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ABSTRACT

This Chemistry-Materials Laboratory Project Book, assembled through a survey of science instructors in vocational-technical schools in Connecticut, is intended to meet a variety of needs. It can serve as an idea book, with the instructor taking from it as needed and adding or substituting material related to class interests; as a guide book for starting or upgrading a laboratory program; or as a laboratory workbook for students. Projects in the book are related to various trades or vocational areas. Some of the laboratories are totally oriented toward chemistry; others are related to the physical aspects of materials. All laboratory experiments require the use of safety equipment. The first four sections of this project book are directed toward the instructor and contain an introduction, suggestions for having a successful laboratory exercise and for managing laboratory materials, and a suggested laboratory report format. The 14 sections following provide materials for student use and are organized into 17 laboratory experiences. The units cover laboratory orientation; laboratory techniques; elements, compounds, and mixtures; acids, bases, and salts; home chemistry; building materials; fuels; molecular oxygen; water; metals; plastics; adhesives; paints; and lists of chemicals used. Each laboratory experience contains an explanation of its purpose, materials required, information, procedures, and notes for the instructor. Charts and diagrams are included where needed. (KC)

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VT-228 CHEM LAB

CHEMISTRY-MATERIALS LABORATORY PROJECT BOOK

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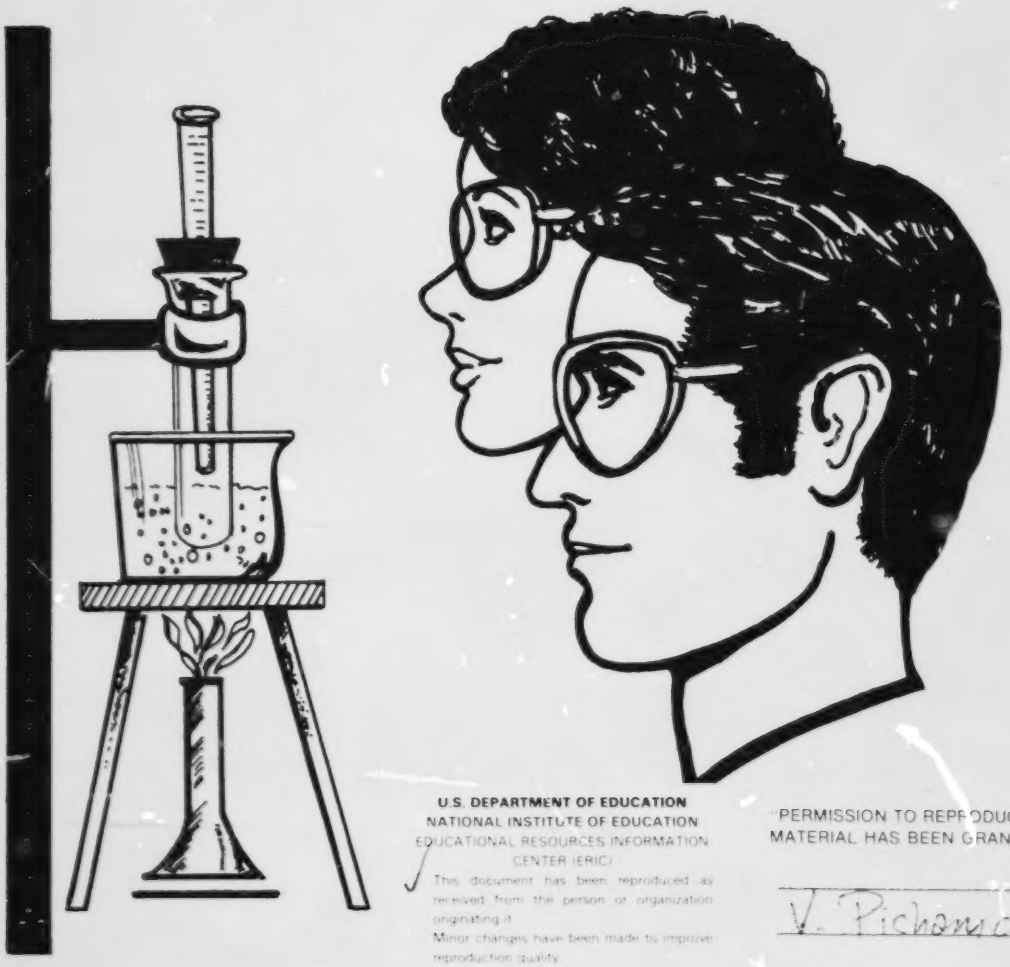

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CONNECTICUT VOCATIONAL-TECHNICAL SCHOOLS

1979-80

CHEMISTRY-MATERIALS LABORATORY PROJECT BOOK

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INTRODUCTION

This Chemistry-Materials Laboratory Project Book is the outgrowth of a survey of related science instructors in our Vocational-Technical Schools. As is the case with any initial project, it represents a well-intended start. It is by no means total and complete. Additions are obvious and necessary, and will be made in the future.

This Laboratory Project Book is designed to meet a variety of needs. It can serve as

1. An IDEA BOOK (the instructor may add or delete material and prepare a lab based on students taught, trades represented, and own background and experience).

2. A GUIDE BOOK (the instructor may be assisted in starting or upgrading a lab program).

3. A LAB BOOK (if satisfactory, the material may be used as a lab workbook).

One major objective when preparing this Project Book was to accumulate a number of lab projects related to various trade or vocational areas. It is obvious that it may contain more lab projects than time allows to complete. It is up to the instructor, then, to plan the lab activities based on the students he/she has.

Some of the labs are totally oriented toward chemistry. Others are related to the physical aspects of materials. Some are very general and basic in nature and apply to all students and trade areas. Others are more specific and apply only to selected students and trades. Again, the discretion is left to the instructor to determine which are to be used.

The following are the goals for the Chemistry-Materials Laboratory Project Book:

1. To develop skills in the use of laboratory equipment and apparatus.
2. To provide motivation and develop an interest in chemistry and materials studied.
3. To develop responsibility and dependability.
4. To develop habits of sound and thorough record-keeping.
5. To develop an orderly approach to the solution of problems.
6. To provide a relationship of chemistry and materials to various trade and vocational areas.
7. To discover new areas of interest and experience.

The following are specific activities for the student in the Chemistry-Materials Laboratory Project Book:

1. Read instructions
2. Follow procedures
3. Set up various apparatus

4. Use various apparatus and equipment
5. Make observations
6. Gather and record data
7. Read instruments
8. Organize data
9. Analyze data
10. Prepare charts, graphs, and diagrams
11. Draw conclusions
12. Communicate results
13. Clean apparatus
14. Practice safety

Since safety must be a habit, it must be noted that ALL labs require the use of safety equipment (e.g. eyeshields, aprons, etc.) regardless of their contents. The intent, obviously, is to make safety commonplace.

SUGGESTIONS FOR HAVING A SUCCESSFUL LAB EXERCISE

The cardinal rule for having a successful lab exercise is "BE PREPARED". This applies to the instructor as well as the students. Preparation covers a large area, a variety of items, but if any little portion of it is omitted confusion and frustration may result and the exercise will be a dismal failure.

Here are some suggestions which an instructor might find helpful to assure success:

The instructor should establish definite rules and requirements related to the organization, administration and operation of the laboratory. These should include student conduct and behavior, safety, lab cleanliness, material organization, etc. The rules should be strictly enforced.

The instructor should be familiar with each lab exercise. The instructor should know how long it should take to perform the exercise, where the problem areas are and what the results should be. When in doubt, the lab exercise should be tested or performed by the instructor beforehand.

The instructor should review the lab exercise with the students in advance of the actual performance. Safety notes and problem areas should be specifically identified. The location of various materials for that particular exercise should be specified. Group assignments should be made in advance of the exercise.

The instructor should be certain that all materials, regardless how small, are available before the start of the actual lab exercise. There should be sufficient quantities to insure completion of the lab.

The instructor should be extremely careful in selecting lab exercises. The exercises should be meaningful and enjoyable to the student. If the lab is eagerly received by the students, the task of administration of performance will be an easy one for the instructor.

The instructor should adopt an adequate planning method. It should include long-range plans for future lab work (it is a little too late to hunt for non-existent materials and supplies the day before the lab). It should also include a disaster plan for a current lab exercise (even with the best of preparation a lab exercise can often fail--have an idea for salvaging what is left, or have an alternative).

The instructor should develop communications with the various shop or trade areas. More often than not, what is done in the science class or in the lab can be linked to what is done in shop or discussed in theory. The shops can become an excellent source for ideas and often a source for certain materials.

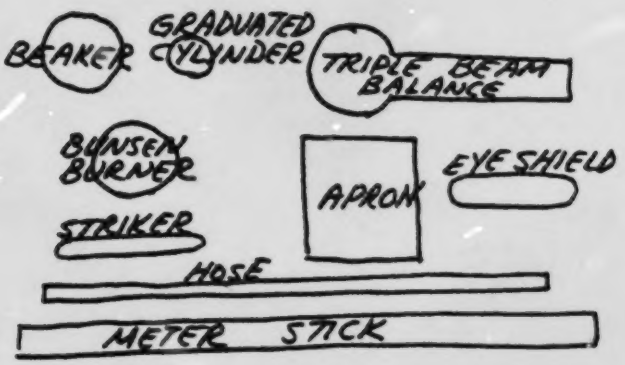
SUGGESTIONS FOR MANAGING LABORATORY MATERIALS

There are many ways to insure that proper materials are available to perform a lab exercise; and, just as important, that these materials are accounted for after the lab. The appropriate method will depend upon a number of variables including available facilities, size of lab group, time available, lab exercise attempted, equipment and supplies available, etc. The following are suggestions that an instructor might find helpful in managing the materials for a lab exercise. Keep in mind that responsibility for management can be shared with the students.

(For the sake of discussion it is assumed that a particular lab exercise requires the following materials: bunsen burner with hose, striker, apron, eyeshield, triple beam balance, meter stick, beaker, graduated cylinder.)

ALTERNATIVE "A"

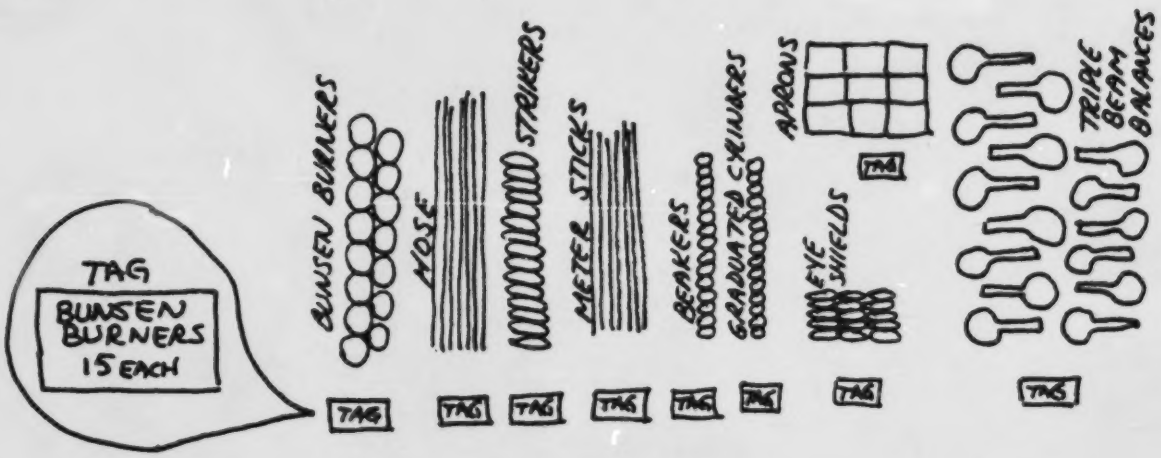
The instructor has all the material placed at each lab station in advance of the lab exercise, following a definite layout. For example:



Every lab station has exactly the same set-up at the outset. Each student is given the layout diagram either on the chalkboard or on the lab sheet. When the lab exercise is completed and the students clean up, the materials should be replaced as indicated by the diagram. This method gives the instructor the advantage of seeing that every group has what it needs at the start of the lab and returns it at the conclusion. The instructor can visually inspect each station and determine if something is missing. Another advantage of this method is that it avoids confusion at the start of the lab exercise when students rush around to get materials to their lab stations.

ALTERNATIVE "B"

The instructor has all the materials neatly arranged in one location prior to the start of the lab. A tag is placed for each item, along with the quantity, near the item. The students all go to one location to get the materials to start the exercise. At the conclusion, the material is neatly returned to the proper location and an inspection can be made. The instructor could assign a student to make the check for order and accountability.



Materials can also be kept in marked trays, bins or tubs when using this method. For example, one tray could contain the bunsen burner, another the strikers, etc. The advantage of this method is that the materials are all kept in one location. This also creates the disadvantage of students all rushing to the same location to secure or return the materials.

ALTERNATIVE "C"

If the lab is equipped with drawers or lockers at each lab station, the management of material could combine the best of the two alternatives previously mentioned.

One approach could be to always have a basic set-up at each station at all times. The drawer or locker would always contain, let's say, a bunsen burner with hose, a striker, a beam balance, an apron and an eyeshield. The other necessary material for that particular lab exercise would be placed in one location for use in that exercise (as discussed in alternative B).

Another approach could be to store particular materials in the drawer or locker at an individual lab station. For example, all aprons are stored at station 1, all eyeshields at station 2, all burners and hoses at station 3, and so on.

At the conclusion of the exercise, all materials are returned to their proper location. The student assigned to that particular station is made responsible for the orderly storage and accounting of the materials there.

ALTERNATIVE "D"

Sometimes there is a problem of not having enough material for each individual lab station or group. This can be overcome in a number of ways depending on the nature of the lab.

One easy solution is to make the lab exercise a demonstration type where the instructor performs the lab making sure to use student assistance. Or, students themselves provide the demonstration.

Another method is to set up special work stations within the lab. The students would do the bulk of their work at their normal lab stations and use the special work station only when required. For example, if there were not enough beam balances for each individual station or group, those that were available could be placed at special work stations. The students would perform their exercise at their normal station and when they needed the use of the balance, they would go to the available special work station.

Still another solution might be to have a series of labs performed in a rotating basis. Depending on the type of lab, the rotation can be done during the lab period itself or it can be done each time the group meets for lab. For example, if each group had to run a quick test on a sample of material (but there wasn't enough for each individual group), a sample of different materials could be placed at each station. When a test was completed at one station, on command, the students would move to the next station for the next test, etc. This would continue until all tests were made. On the other hand, if each exercise was to take the entire lab period, then the groups could start on different lab exercises and change the next time they meet. This again would be continued until all exercises are completed.

A SUGGESTED FORMAL LAB REPORT FORMAT

NAME:_____

CLASS:_____

TRADE:_____

LAB REPORT NO._____

"TITLE OF LAB OR EXPERIMENT"

OBJECTIVE(S):

What the purpose of the lab or experiment is; what results are anticipated; or what is to be proven. Should be concise.

DIAGRAM AND/OR LIST OF MATERIALS:

A simple, but complete, diagram of the experiment apparatus. If diagram is properly labeled, the list of materials should be eliminated (it would be incorporated in the diagram). If the lab is such that a diagram is inappropriate, then a list of materials should be given.

PROCEDURE AND OBSERVATIONS:

Explain briefly, yet fully, what was done, how it was done, and what was observed. An outline form can be used. Use charts, tables, graphs, diagrams, etc. as necessary (this often eliminates a great deal of unnecessary writing and permits a quick securing of data or information).

RESULTS AND CONCLUSIONS:

Explain briefly, yet completely, the final results obtained. State the proof. Use sound reasoning. State conclusions in reference to the objectives listed in the beginning. Use charts, tables, graphs, diagrams, etc. as necessary.

LABORATORY

ORIENTATION

Title: Ten Minute Time Test

Unit: Laboratory Orientation

Course: Chemistry/Materials

1. Read everything before doing anything.
2. Put your name in the upper right hand corner of this paper.
3. Circle the word "name" in sentence two.
4. Draw five small squares in the upper left hand corner of this paper.
5. Put an "X" in each square.
6. Put a circle around each square.
7. Sign your name under the title of this paper.
8. After the title, write "YES"? "YES"? "YES".
9. Put a circle around sentence number seven.
10. Put an "X" in the lower left hand corner of this paper.
11. Draw a triangle around the "X" you just put down.
12. On the back of this paper, multiply 703 by 66.
13. Draw a rectangle around the word "paper" in sentence number four.
14. Loudly call out your first name when you get to this point.
15. If you think you have followed directions carefully to this point call out loud "I have".
16. On the reverse side of this paper add 8950 and 9805.
17. Put a circle around your answer, and put a square around it.
18. Count in your normal speaking voice from ten to one backwards.
19. Punch three small holes in the top of this paper with a pencil.
20. If you are the first person to get this far, call loudly, "I am the first person to this point and I am the Leader in this class."
21. Underline all even numbers on this side of the page.
22. Put a square around every number which is written out on this page.
23. Say out loud, "I AM NEARLY FINISHED, I HAVE FOLLOWED DIRECTIONS".
24. Now that you have finished reading carefully, do only sentence two. Turn your paper over and raise your hand.

Title: Ten Minute Time Test

INSTRUCTOR'S NOTES

This time test should be administered as an informal activity to emphasize the importance of following directions:

COMMENTS:

Title: Laboratory Safety Rules and Regulations

Unit: Laboratory Orientation

Course: Chemistry/Materials

1. Absolutely no horseplay in the lab.
2. All instructions for the labs are to be followed carefully and exactly as indicated. When chemicals are identified or when quantities are specified, read that information over again to be certain that you have it correct. Always read, and re-read, the chemical labels on containers. If you have any questions, ask your instructor.
3. Perform no unauthorized experiments.
4. Working in the lab alone is not allowed. All lab work is to be done during the regular lab period.
5. If you are cut, burned, inhale fumes, or are injured in the lab in any way, notify the instructor at once so appropriate action may be taken.
6. In case of fire, clear the area and notify the instructor at once. Note where the fire extinguisher is located. Remember that wet towels are also efficient for smothering flames.
7. If a person's clothing catches fire, make the person lie down, then smother the flames with a blanket. Be especially careful of loose clothing and clothing of synthetic material when working with open flames. Always wear a lab apron to protect clothing.
8. Do not taste anything in the lab.
9. Exercise great care when noting the odor of fumes and avoid breathing fumes of any kind.
10. Do not use your mouth for suction when filling pipettes or tubing with a chemical reagent.
11. Wear approved eye protection when in the lab. If you get anything in your eye, wash it with flowing water for 15 to 20 minutes. Report the incident to your instructor.
12. Do not force glass tubing into stoppers. Use a towel to protect your hands.
13. Clean up all broken glass and chemicals immediately. Do not use your hands; use a brush or towel. Dispose of glass and chemicals in the special container designated by your instructor. Do not use the regular trash can. Do not dump chemicals into the sink unless directed to do so by your instructor.
14. Confine hair when in the lab.
15. When heating a substance, always point it away from everyone. Allow burners and other apparatus to cool before moving them.

I have read these rules and will observe them for this course.

Signature_____

Title: Laboratory Safety Rules and Regulations

INSTRUCTOR'S NOTES

The safety rules and regulations should be thoroughly reviewed and discussed.

Specific locations of, for example, the fire extinguisher, eye wash fountain, emergency shutoffs, emergency exits, etc. should be listed on the sheet.

The student should sign the sheet and it should be kept on file.

The rules should be enforced at all times.

A lab safety test may also be prepared and administered. It should also be kept on file. A passing score should be determined before the student is allowed to work in the lab.

Instructor should contact the school nurse to ascertain accepted procedures in the event of injury or accident.

COMMENTS:

LABORATORY

TECHNIQUES

Title: LAB--Introduction to General Laboratory Procedures

Unit: Laboratory Techniques/Systems of Measurement

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with various laboratory procedures and to utilize the metric system.

Materials Required:

Meter stick, triple beam balance, 100 ml. graduated cylinder, weighing paper, metal scoop, 100 ml. beaker, 250 ml. beaker, 200 gm. standard weight, sand, water, regular solid sample, irregular solid sample, apron, eye shield.

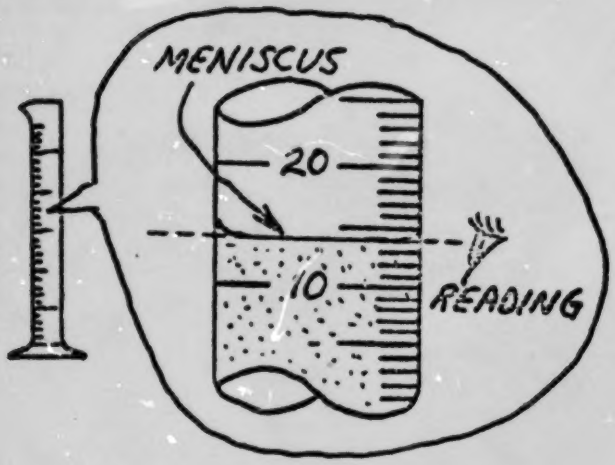
Information:

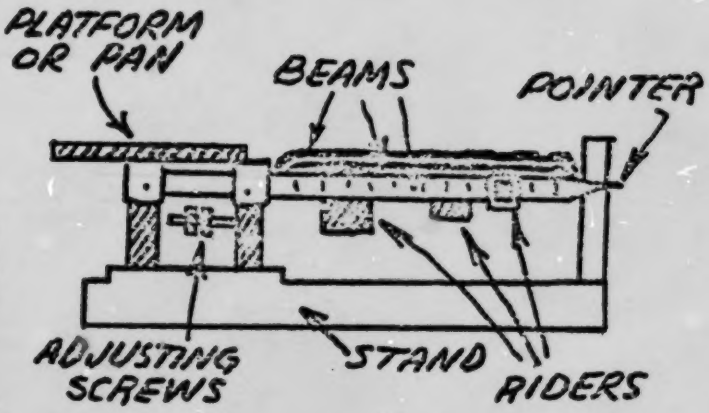
HANDLING SOLID SUBSTANCES.....A metal scoop is often used to dip out chemicals. NEVER USE MORE THAN THE DIRECTIONS INDICATE. Excessive amounts of chemicals are NEVER returned to the storage container. This practice avoids contamination. Any chemicals that may be accidentally spilled MUST BE CLEANED UP IMMEDIATELY.

MEASURING MASS.....When weighing solid substances ALWAYS USE WEIGHING PAPER to protect the weighing pan and the chemical itself from contamination. Weighing paper also makes it easier to transfer the chemical from the pan to wherever it is being used. If the quantity weighed is very large, a container such as a beaker or evaporating dish may be substituted for the weighing paper. The beam balance is often used to weigh (measure mass) solids. It should be handled and cared for like any delicate instrument. Always check the balance to see that it is clear of foreign materials and that it is zeroed-in. ONLY IF THE BALANCE WILL NOT ZERO-IN, make adjustments carefully with the adjusting screws. IF A PROBLEM SHOULD STILL EXIST, CONTACT YOUR INSTRUCTOR.

MEASURING LENGTH.....In the lab, a meter stick is generally used to measure length. Usually it has metric calibrations or graduations on one side and English units on the other. BE CERTAIN TO USE THE CORRECT SIDE OF THE METER STICK WHEN MEASURING. When the length is recorded, always be certain to use the proper label. Double check all measurements.

MEASURING VOLUMES OF LIQUIDS.....For approximate measurements, a graduated cylinder is generally used. These cylinders are usually graduated in milliliters (ml). For more accurate liquid measurements either a pipette or buret is used. The surface of the liquid in the graduated cylinder is curved (either concave or convex). This is caused by the attraction of the walls of the cylinder for the liquid. The curved surface is called the MENISCUS and all measurements must be made at the center or middle of it.





MEASURING DENSITY.....Density is defined as the mass per unit volume. It can be computed by determining the mass of the substance and its volume, then dividing the mass by the volume. For regular objects, linear measurements are made and the volume is computed using a formula for that shaped object. However, if the object is irregular (has an irregular shape) its volume must be determined by another method such as DISPLACEMENT. In this method, the object will displace water in the amount equal to its own volume; therefore, the volume of the water displaced is the same as the volume of the irregular object.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. KEEP WORK STATION CLEAN AND IN ORDER. DO YOUR OWN WORK. PRACTICE SAFETY AT ALL TIMES. CALL YOUR INSTRUCTOR IF ASSISTANCE IS NEEDED.

PART ONE.....MEASURING MASS

1. Check the beam balance to see that the pan is clear of foreign materials and that all the weights are in the zero position. ONLY IF THE BALANCE WILL NOT ZERO-IN, make adjustments with the adjusting screws. If a problem still exists, contact your instructor.

   Explain briefly, how you know the balance is zeroed-in.

2. Weigh the standard 200-gram weight and determine if the balance is accurate.

   Weight of standard = _____ grams

Title: LAB--Introduction to General Laboratory Procedures

3. Weigh each of the following and record their weights. Remember to use proper labels.

   Metal scoop = _____

   Empty 100 ml graduated cylinder = _____

   Empty 250 ml beaker = _____

4. As directed by your instructor, fill the 100 ml. beaker about half way with sand. AVOID ANY SPILLAGE.

5. Place weighing paper on the pan of triple beam balance.

   Weight of weighing paper = _____ grams

   Add two (2) grams to the weight indicated on the beam and move the rider to that value. The balance should now indicate the weight of the weighing paper PLUS two grams.

   Indicated weight = _____ grams

6. Using scoop, CAREFULLY sprinkle sand from the beaker onto the weighing paper (on pan) until the balance indicates zero. At this point, the weight of the sand without the weighing paper is _____. INSTRUCTOR'S INITIALS _____.

7. The weight of the 250 ml. beaker (step 3) was _____ grams. Add all the sand that remains in the small beaker to this larger beaker.

   Weight of sand and beaker is _____.

   Weight of sand alone is _____.

   RETURN ALL SAND TO THE AREA DESIGNATED BY YOUR INSTRUCTOR AND BE CERTAIN THAT ALL EQUIPMENT IS CLEAN.

PART TWO.....MEASURING VOLUMES OF LIQUIDS

1. Fill the 100 ml. beaker with water. BE CAREFUL WHEN TURNING ON WATER AT THE LAB STATIONS (the force is great since the spigot has a nozzle to concentrate the flow).

2. Pour water CAREFULLY from the beaker into the graduated cylinder, measuring EACH of the following quantities: 10 ml., 13.2 ml., 19 ml., 22.5 ml., and 25 ml. SAVE THE 25 ml. QUANTITY FOR PART FOUR OF THIS LAB. Have ONE of these quantities checked by your instructor. The measurement to be checked is _____ ml. INSTRUCTOR'S INITIALS _____.

CLEAN WORK STATION. PLACE THE GRADUATED CYLINDER IN A SAFE LOCATION SO IT IS NOT ACCIDENTALLY TIPPED OVER.

Title: LAB--Introduction to General Laboratory Procedures

PART THREE.....MEASURING LENGTH

1. Examine the meter stick. The number of centimeters in a meter are_____. The number of millimeters in a centimeter are _____. The number of millimeters in a meter are_____.

2. Measure the following items. Be certain to label your measurements.

   Length of metal scoop = _____

   Height of lab bench = _____

   Width of this lab sheet = _____

   Depth of lab sink = _____

   Thickness of meter stick (???) = _____

INSTRUCTOR'S INITIALS_____

PART FOUR.....MEASURING DENSITY

1. The weight (mass) of the regular solid is _____ grams.

2. Measure the regular solid. Draw a sketch and label its dimensions. Make all your measurements in centimeters.

3. The formula you would use to calculate its volume is _____. INSTRUCTOR'S INITIALS_____.

4. Calculate the volume. The volume is _____ cubic centimeters.

5. Calculate the density by dividing the mass by the volume. The density is _____grams per cubic centimeter.

6. Take the graduated cylinder with the 25 ml. of water (from Part Two) and CAREFULLY weigh it.

   Weight of cylinder and water is _____ grams.

7. The original weight of the empty graduated cylinder (refer to Part One) was _____ grams.

   Weight of water alone is _____ grams.

   It can be said that the density of water is _____ gm/ml. or gm./cu.cm. INSTRUCTOR'S INITIALS _____.

8. The weight of the irregular solid is _____ grams.

9. CAREFULLY put additional water into the graduated cylinder so that it is at least half full. The amount of water now in the graduated cylinder is _____ ml.

10. CAREFULLY place the irregular solid into the graduated cylinder. DO NOT DROP SOLID INTO CYLINDER. The water in the cylinder has risen so the new reading is _____ ml.

11. The difference between the two readings is the volume of water that was displaced. The volume of water displaced is _____ml. The volume of the irregular solid is _____ cu. cm. INSTRUCTOR'S INITIALS _____.

12. Calculate the density of the irregular solid by dividing its mass by its volume. The density is _____ gm./ cu. cm.

CLEAN UP YOUR WORK STATION. BE CERTAIN THAT ALL THE EQUIPMENT IS PLACED AS DIRECTED BY YOUR INSTRUCTOR. INSTRUCTOR'S INITIALS_____.

Title: LAB--Introduction to General Laboratory Procedures

INSTRUCTOR'S NOTES

It is recommended that plastic graduated cylinders, beakers, etc. be used for the lab. Their use reduces the problem of breakage.

COMMENTS:

Title: LAB--Bunsen Burner and Glassworking

Unit: Laboratory Techniques

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

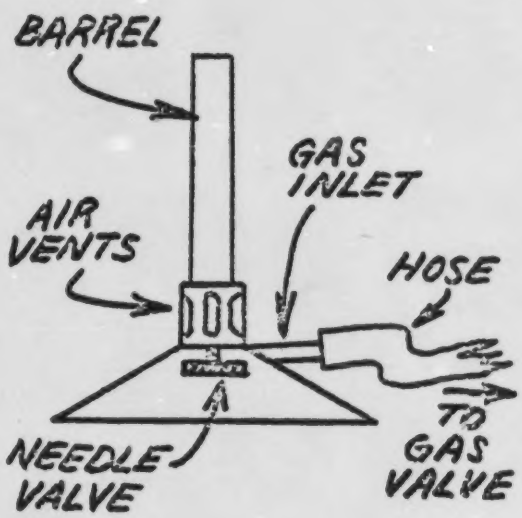
To become acquainted with the bunsen burner and with techniques for preparing glass rods and tubing for laboratory use.

Materials Required:

Meter stick, bunsen burner, wing top flame spreader, striker, asbestos pad, triangular file, tongs, asbestos mitts or gloves, platinum wire, 6 mm. glass tubing, 6 mm. solid glass rod, eye-shield, apron.

Information:

The bunsen burner is commonly used in the laboratory for heating operations. Although each burner may look different, the parts and their functions are similar. Each burner has a gas inlet (located in the base), a barrel (in which the gas is mixed with air), and adjustable openings (located in the base of the barrel to introduce air into the gas stream). The gas supply may be regulated by adjusting the gas valve on the supply line (if necessary, fine adjustment is made with the needle valve). THE BURNER IS ALWAYS TURNED OFF AT THE GAS VALVE ON THE LAB BENCH.



In laboratory work, glass tubing and rubber stoppers are often used in performing and experiment. The preparation and use of these materials is simple enough; however, if done improperly, a defective apparatus may result. More important than this, severe cuts and burns may be the prospect.

Along with the use of the bunsen burner, this lab will deal primarily with the cutting, firepolishing, and bending of glass tubing. In relation to the glass tubing, points will be mentioned as the lab progresses. The insertion of this tubing into stoppers will not be covered in this lab, but some important points will be mentioned now.

Title: LAB--Bunsen Burner and Glassworking

PAGE TWO

INSERTING TUBING INTO STOPPERS.....Always protect the hands with a towel or rag when inserting or removing tubing from stoppers. Lubricate the hole in the stopper with glycerin (glycerol). Use a stirring rod to make certain that the lubricant gets into the hole. Grip stopper with one hand and grip tubing, close to the end being inserted into stopper, with the other hand. Twisting gently, gradually work tubing into stopper.

REMOVING TUBING FROM STOPPERS.....With hand protected, carefully grip tubing close to the stopper and twist out of the hole. Never force the tubing if it is stuck.

Procedure:

FOLLOW ALL DIRECTIONS. BE CERTAIN TO KEEP YOUR WORK AREA CLEAN AND IN ORDER. DO YOUR OWN WORK. IF ASSISTANCE IS REQUIRED CONTACT YOUR INSTRUCTOR. REPORT ALL INJURIES IMMEDIATELY TO YOUR INSTRUCTOR.

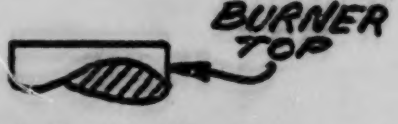
PART ONE.....BUNSEN BURNER

1. Take bunsen burner and examine its parts. Note, in particular, how the air supply is controlled by opening and closing the air ports or vents (different models of burners are used, so be certain you understand how your burner operates).

2. Properly connect the burner to the gas valve. Check the gas line (hose).

3. Turn the gas valve on and, with striker, light the burner. BE CAREFUL OF FLAME. Open and close the air ports (vents) to get the feel of how the flame can be controlled.

4. Close the air ports. Describe the characteristics of the resulting flame:



5. Adjust the air ports until the flame is steady, quiet, and has a well-defined cone.

6. Note the hottest and coolest part of the flame by passing a platinum wire through the flame, starting at the tip and extending down to the top of the barrel. Sketch the flame, below, labeling the hottest and coolest parts along with their colors (if possible).

Title: LAB--Bunsen Burner and Glassworking

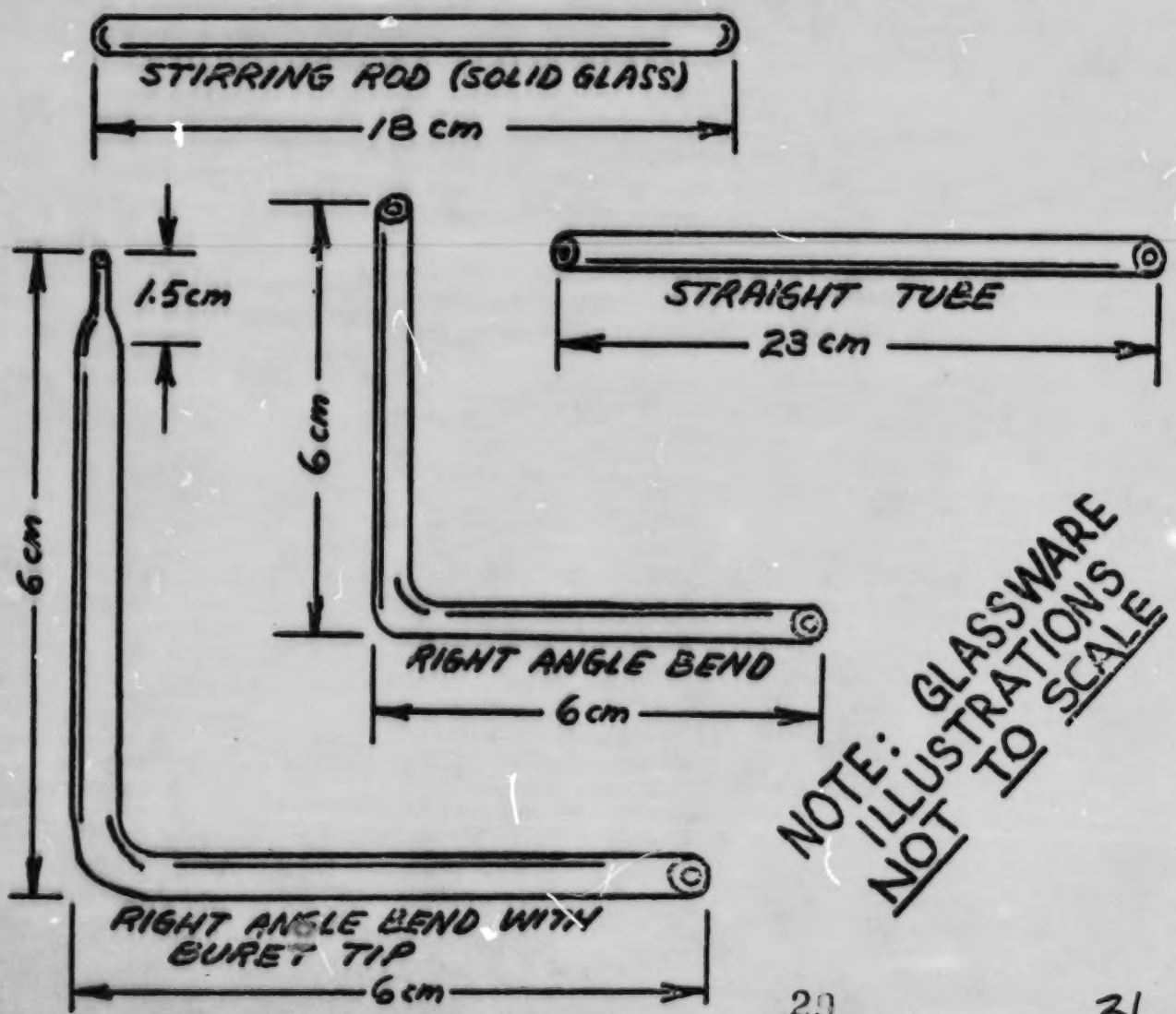
7. Turn off burner. ALLOW BURNER TO COOL BEFORE HANDLING.

PART TWO.....GLASSWORKING

1. READ THE ENTIRE PROCEDURE BEFORE STARTING WORK.

2. HANDLE ALL GLASSWARE WITH CARE. IT IS FRAGILE, AND IF IT IS NOT HANDLED PROPERLY, CUTS MAY RESULT.

3. Get a length of tubing from your instructor. If solid glass rod is available, get a length of that, too. Review the sketches to determine if all the glassware can be secured from the material you received. The total length of tubing required for this lab is _____ cm. The amount of solid glass rod is _____ cm.
INSTRUCTOR'S INITIALS _____.



4. Do not waste any tubing. DO NOT THROW ANY BROKEN GLASS INTO THE REGULAR TRASH CAN. NOTIFY YOUR INSTRUCTOR OF ANY BREAKAGE AND HE WILL DISPOSE OF IT, OR INSTRUCT YOU WHERE TO DISPOSE OF IT.

5. Make tubing with pencil or pen at the point where cut is to be made. CHECK ILLUSTRATIONS, THEN CHECK MARKS ON TUBING.

6. Hold tubing about 1 cm. from the mark. Be certain that it is in position, lying flat, on the lab bench. Grip file by handle or tang and press EDGE of file firmly against tubing at the mark. Make sure the file is at right angle to tubing (to get square cut) and make a scratch by PUSHING FILE AWAY FROM YOU. DO NOT SAW. Usually one one stroke is needed for the scribe mark. If other strokes are necessary, due to a dull file or lack of sufficient pressure against the tubing, make sure that the subsequent strokes follow the same scratch mark. The scribe or scratch mark DOES NOT need to be deep or long, but it should be well defined.

7. After cut is made, grip tubing with thumbs together directly OPPOSITE the scratch mark. Apply pressure with thumbs pushing away from body as if the ends of the tubing are to be brought to the sides of the body. At the same time the tubing should be SLIGHTLY pulled as if it were being pulled apart.

8. A clean break should result. Use flat side of file to remove any rough part from the ends of the tubing. After completing one of your cuts (after one item of glassware has been cut to size) have it checked by your instructor. INSTRUCTOR'S INITIALS_____.

9. When making the right angle bend with the buret tip, it will be necessary to form the glassware BEFORE making the cut. THINK FIRST!!! PLAN AHEAD!!!

10. After all items have been cut to size, return all unused tubing to the area designated by your instructor. Return to lab station and set up and adjust your bunsen burner. BE CERTAIN THAT THE WING TOP FLAME SPREADER HAS BEEN ATTACHED TO THE BARREL BEFORE LIGHTING BURNER.

11. Firepolishing is a process of removing sharp edges of glass by heating the tubing in the burner flame. Grasp the item to be polished and, while continuously rotating with the hand, heat the end in the hottest part of the flame until the sharp edges are smooth. DO NOT TOUCH THE TUBING AS IT WILL BE HOT. YOUR INSTRUCTOR DOES NOT APPRECIATE THE ODOR OF BURNING FLESH. DO NOT OVERHEAT THE TUBING AS THE BORE (HOLE) IN THE TUBING WILL BE CONSTRICTED (MADE SMALLER).

When polishing is completed, place the item on the asbestos pad to cool. DO NOT HANDLE HOT TUBING. If more than one end has to be firepolished, polish one end, LET IT COOL, then polish the other end. When polishing the stirrer, the end should be smooth and rounded (if made out of glass tubing, it should also be sealed) when completed. Have your instructor check at least one firepolished item. INSTRUCTOR'S INITIALS_____.

12. To bend tubing, grip tubing at ends and hold lengthwise in flame just above hottest part. Rotate continuously until tubing becomes soft enough to bend easily. Remove tubing from flame and QUICKLY, but CAREFULLY, bend to the required shape. Place tubing on asbestos pad to cool. If tubing is too short to hold in both hands, heat tubing and then make bend using tongs or the tang of a file. Another method is to use a long piece of tubing to make the desired bend, then cut it to length after it has cooled. Have your instructor check at least one bent item. INSTRUCTOR'S INITIALS_____.

13. Identify all glassware items with your names and lab group numbers and place in location designated by your instructor for use in future labs.

CLEAN UP YOUR WORK STATION. BE CERTAIN THAT ALL EQUIPMENT IS IN ITS PROPER PLACE. INSTRUCTOR'S INITIALS_____.

Title: LAB--Bunsen Burner and Glassworking

INSTRUCTOR'S NOTES

It is recommended that the proper hose be used for the bunsen burner. In the interest of safety, use bunsen burner hose (which is usually a fiber and rubber material) and be certain that it has the proper hose connectors.

COMMENTS:

Title: LAB--Introduction to Graphing

Unit: Laboratory Techniques

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To study how the temperature changes when a liquid cools to a solid state and to display the resulting information graphically.

Materials Required:

Naphthalene, acetamide, benzoic acid, triple beam balance, eye shield, apron, water, 2 test tubes, 250 ml. beaker, bunsen burner, metal scoop, weighing paper, thermometer (Celsius scale), ring stand, ring, wire gauze, 2 ring stand clamps, test tube rack, split 1-hole stopper, test tube brush, striker, asbestos mitts or gloves, clock or other timing device, graph paper.

Information:

The change in state of a substance from a liquid to a solid is called freezing; the change in state from a solid to a liquid is called melting. Generally, these both occur at the same temperature. When the solid and liquid phases are in equilibrium, the fixed temperature is known as the freezing or melting point.

A pure substance will freeze or melt at a fixed temperature. If another substance is added to it, even in small amounts, the freezing point will be lowered.

Often when a substance is being cooled, crystals will begin to form at a temperature that is far below the normal freezing point. This is called supercooling. When this occurs, the temperature will rise again because of the heat released in the crystallization process.

The temperature of a substance normally decreases as it cools. If the substance is a liquid and it approaches the solid state, the temperature may remain nearly constant for a while. This indicates the areas where the latent heat of fusion has been reached. In other words, the heat that is lost is used to change the state of the substance and not its temperature. Once the change in state has been completed, the temperature may then continue to decrease.

In a lab, when data is being collected, it must be done in an organized manner. One way to accomplish this is to set up and use a table. A good table effectively consolidates and displays information. However, even with a proper table, it is often difficult to compare sets of numbers or information. A graph may be necessary as it is often the clearest way to represent data and portray the relationship between them. In effect, it is a "picture display" of numbers.

Title: LAB--Introduction to Graphing

PAGE TWO

There are various types of graphs, but the one that will be considered and used for this lab is the rectangular coordinate system (also known as the x-y or cartesian coordinate system). It consists of a horizontal axis (called the x-axis or abscissa) and a vertical axis (called the y-axis or ordinate). Normally it is advisable to plot the independent or controlled variables along the horizontal axis, and the dependent or uncontrolled (experimental) variables along the vertical axis. For example, in this lab, the time of the temperature is specified and obviously controlled--this is the independent variable. On the other hand, the resulting temperature at that moment is uncontrolled and is the dependent variable. The axes should be labeled to identify the specific variable.

This graph consists of a series of points, each of which has an x and y value (in this lab, at a specified time, there is an observed temperature reading). Once the series of points are plotted, they are connected with a smooth curve (this term is used in a broad sense to denote a line which may be straight or curved but which does not show any abrupt change in direction).

To show sets of information, for comparative purposes, it may be better to make the display together rather than separately. In this case, all sets are plotted on the same graph. To distinguish between each set, the curves are labeled or color (use a different color for each set) or line (use a different line for each set, e.g., dotted, dashed, solid, etc.) coded. Whatever the choice, the curves should be identified. The graph should be titled.

Procedure:

FOLLOW ALL DIRECTIONS. BE CERTAIN TO KEEP YOUR WORK STATION CLEAN AND IN ORDER. DO YOUR OWN WORK. PRACTICE SAFETY AT ALL TIMES.

1. Set up the apparatus as diagrammed on the following page. BE CERTAIN THAT ALL EQUIPMENT IS CLEAN AND DRY.

2. Place approximately 200 ml. of water into the beaker. Place the beaker on the ring stand and heat the water to boiling.

3. While waiting for the water to boil, weigh 4.5 grams of ACETAMIDE and place it in a clean, dry test tube. REMEMBER TO USE WEIGHING PAPER. The chemical formula for acetamide is $CH_3\ CONH_2$.

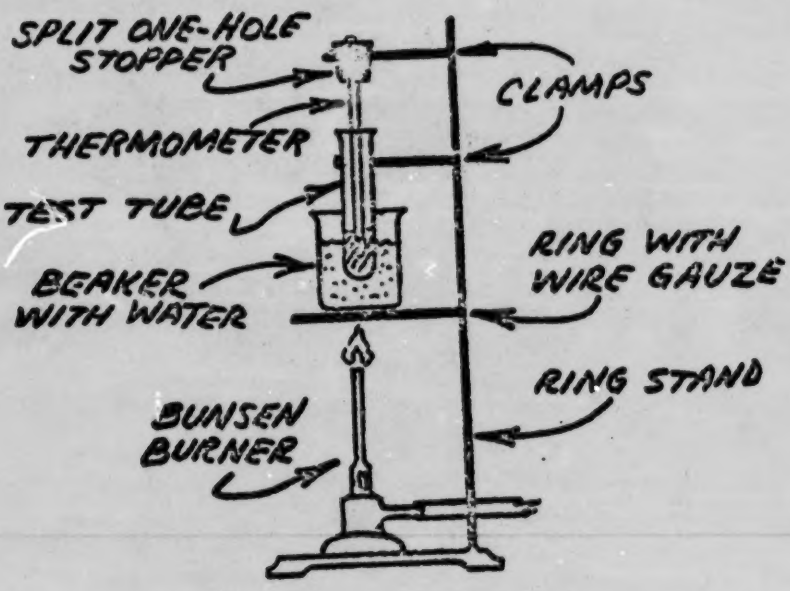
4. Immerse the test tube into the beaker of water and clamp it in place.

5. Insert the thermometer into the test tube and clamp it so that it is centered. BE CERTAIN THAT IT IS CLAMPED SO THAT IT CAN BE READ PROPERLY.

Title: LAB--Introduction to Graphing

PAGE THREE

6. After the acetamide has melted, continue heating until a temperature of 95°C. is reached. This is time ZERO. Immediately turn off and remove the bunsen burner. CAREFULLY REMOVE the beaker of water and the ring. REMEMBER, IS IS HOT.



7. Starting at time ZERO, continue recording the temperature every 30 seconds (1/2 minute) and record the data in the chart. Mark with an asterisk (*) the temperature when crystals are FIRST noted. Continue taking readings for a total of 15 minutes. REMEMBER TO USE THE CELSIUS THERMOMETER SCALE.

8. Add 0.25 grams of BENZOIC ACID to the test tube containing the acetamide WITHOUT REMOVING THE THERMOMETER. Return the beaker, ring, and burner and boil the water in the beaker again. The chemical formula for benzoic acid is C_6H_5COOH.

9. REPEAT STEPS 6 and 7, this time with the combination of acetamide and benzoic acid. Record the data on the chart.

10. After step 9 is complete, heat the test tube in boiling water, REMOVE THE THERMOMETER CAREFULLY and clean it with water. Empty and clean the test tube. Place the substance where directed by your instructor. DO NOT DUMP INTO SINK.

11. Weigh 4.5 grams of NAPHTHALENE and place it in the other clean, dry test tube. REPEAT STEPS 4 thru 7 with the naphthalene. The formula for naphthalene is $C_{10}H_8$.

12. Plot the data from your chart on graph paper. Use color and labels to identify each of the three curves. Starting at 30°C, let each line on the vertical scale equal 2C°. Stop at 100°C. Starting at time ZERO, let each line on the horizontal scale equal 1/2 minute. Stop at 15 minutes. Plot all the points carefully and connect them with a smooth curve. Label the freezing points. Label the supercooling points, if any.

CLEAN UP YOUR WORK STATION. PLACE ALL EQUIPMENT AS DIRECTED BY YOUR INSTRUCTOR. INSTRUCTOR'S INITIALS _____.

Title: LAB--Introduction to Graphing

TIME (min.)	TEMPERATURE (°C)		
	ACETAMIDE	ACETAMIDE-BENZOIC ACID	NAPHTHALENE
0.0			
0.5			
1.0			
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			
5.5			
6.0			
6.5			
7.0			
7.5			
8.0			
8.5			
9.0			
9.5			
10.0			
10.5			
11.0			
11.5			
12.0			
12.5			
13.0			
13.5			
14.0			
14.5			
15.0			

NOTE WHERE CRYSTALS WERE FIRST OBSERVED WITH AN ASTERISK (*)

Title: LAB--Preparation of Culture Media

Unit: Laboratory Techniques

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To prepare a culture medium for bacteria growth.

Materials Required:

Bunsen burner, striker, ring stand, ring, wire gauze, asbestos mitts or gloves, 7 sterilized petri dishes, 500 ml erlenmeyer flask (beaker, boiling flask, etc. may be substituted), 100 ml graduated cylinder, triple beam balance, water (distilled is recommended), agar, beef bouillon, sterilized muslin (optional), apron, eye shield.

Information:

Bacteria lack chlorophyll and belong to a group of plants called fungi. They cannot manufacture their own food and must, therefore, rely on other substances for nourishment.

Bacteria are grown in the lab in specially prepared media. These culture media are generally made with agar and a nutrient. Agar is a gelatin that forms a jello-like solid at room temperature (it is a liquid at approximately 90°C). The nutrient that will be used in this lab is beef bouillon.

The culture medium is often placed in a petri dish. It is allowed to gel and becomes the environment into which the bacteria is introduced. When the bacteria multiplies, it forms millions of cells that appear as a tiny spot in the culture medium. This spot is called a colony.

In this lab, you will merely prepare a culture medium that could be used in other labs dealing with the study of bacteria.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR AREA CLEAN AND IN ORDER. PRACTICE SAFETY AT ALL TIMES.

1. Prepare bunsen burner and ring stand for heating operation.
2. Place 200 ml of distilled water in the 500 ml erlenmeyer flask.
3. Weigh 3 grams agar and 1 gram beef bouillon. Place these solids in the flask and swirl around to dissolve some of it.

Title: LAB--Preparation of Culture Media

4. Place flask and its contents on ring stand. Heat to boiling. Boil for 10 to 15 minutes. USE CAUTION AS THIS SOLUTION HAS A TENDENCY TO BOIL OVER.

5. Using the asbestos mitts or gloves, remove the flask. Uncover a petri dish and quickly pour in some of the culture medium. Do not fill the petri dish (a few millimeters, depth, is often sufficient). Just as quickly, replace the cover on the petri dish.

6. Repeat the process until all the petri dishes are filled. The culture medium you prepared should be sufficient to fill about 7 dishes.

7. Allow the petri dishes to stand and cool so that the culture medium can gel.

8. Place the petri dishes, just prepared, in the area designated by your instructor. Handle them carefully. Be certain that they remain covered to avoid the premature introduction of bacteria.

CLEAN YOUR WORK STATION. MAKE CERTAIN THAT ALL GLASSWARE IS CLEAN AND THAT ALL EQUIPMENT HAS BEEN PLACED IN ITS PROPER LOCATION.
INSTRUCTOR'S INITIALS_____.

Title: LAB--Preparation of Culture Media

INSTRUCTOR'S NOTES

Although distilled water is recommended, in most cases the results will be satisfactory if ordinary tap water is used.

Pre-sterilized, disposable, petri dishes are recommended. Keep in mind that these dishes are plastic and if a lab requires their use in a high temperature environment, distortion and warping may result.

If petri dishes are not available, in some cases (depending on the lab) a sterilized test tube may be used. A wad of sterilized cotton is stuffed in the mouth of the tube to keep out the bacteria.

If agar is not available, a successful medium can be produced as follows: (You may wish to have the students bring in the necessary materials).

Boil 2½ points of water and dissolve 1 box of Knox Gelatin in it (1 box contains 1 ounce or 4 envelopes).
Stir in 1 bouillon cube until it dissolves.
Add a pinch of salt.
Pour into petri dishes.
This will fill about 8 or more dishes.

COMMENTS:

ELEMENTS, COMPOUNDS AND MIXTURES

Title: LAB--Separation of Mixtures

Unit: Elements, Compounds and Mixtures

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with methods of separating mixtures into its components.

Materials Required:

Ring stand, ring, bunsen burner, strikes, funnel, filter paper, triple beam balance, ring stand clamp, weighing paper, 100 ml graduated cylinder, 3 test tubes, test tube rack, 2 - 100 ml beakers, 2 one-hole stoppers, 1 right angle tubing, glycerine, water, sand, sodium chloride, iron filings, magnet, apron, eye-shield, stirring rod, metal scoop.

Information:

In laboratory work one is often confronted with the problem of separating substances. The following methods of separation are applied to solutions and suspensions.

DECANTATION.....Solution is allowed to stand for a period of time and settlement is permitted. The clear liquid that remains is poured off carefully and the undissolved particles are allowed to remain in the original container.

FILTRATION.....Mixture is poured through a funnel containing filter paper. The liquid that comes through the filter paper is called the filtrate, while the material that remains on the filter paper is called the residue.

DISTILLATION.....This process involves both evaporation and condensation. The liquid is heated and allowed to evaporate, passing through a tube to a condensor (where the evaporated substance is allowed to cool to permit condensation). The liquid which condenses is called the distillate. Anything that will not evaporate remains behind as a residue.

MECHANICAL.....This process involves such physical means of hand-picking, sifting, use of magnet, etc.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. BE CERTAIN TO KEEP YOUR WORK AREA CLEAN AND IN ORDER AT ALL TIMES. DO YOUR OWN WORK. PRACTICE SAFETY AT ALL TIMES.

1. BEFORE HANDLING GLASSWARE OR USING RUBBER STOPPERS AND TUBING REFER TO LAB--BUNSEN BURNER AND GLASSWORKING. GLASS IS FRAGILE AND CARELESSNESS CAN RESULT IN SERIOUS CUTS OR SLASHES.

Title: LAB--Separation of Mixtures

2. Using the graduated cylinder, measure 12.5 cubic centimeters of tap water. This is the same as _____ milliliters. Pour this water into one of the beakers.

3. Check the triple beam balance for zero.

4. Place weighing paper on the platform of the balance. The weight of the weighing paper is _____grams. Weigh each of the following solids and pour them into the beaker with the tap water; 1 gram iron filings, 1.75 grams of sand, and 1 gram NaCl.

5. Stir the contents of the beaker well. The total mass of all the solids in the beaker is _____ grams.

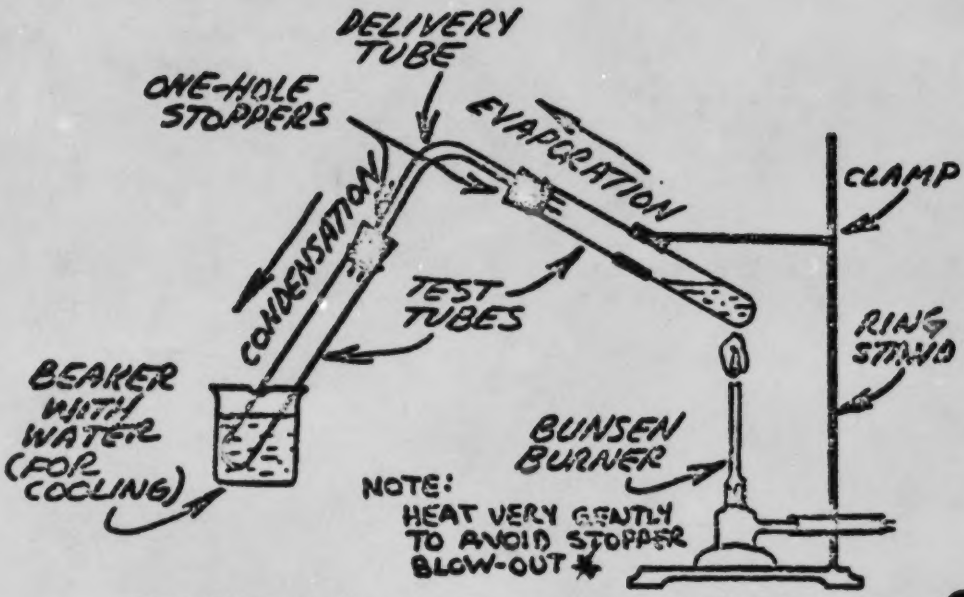
6. In order to separate this mixture, study the materials which compose it and list the method for separation below and what each method will yield. List each method IN THE ORDER IN WHICH YOU WOULD PERFORM THE SEPARATION.

	Method	Product
A.	_____	_____
B.	_____	_____
C.	_____	_____
D.	_____	_____

Instructor will check your method first BEFORE PROCEEDING. INSTRUCTOR'S INITIALS_____.

7. Separate the mixture. Place each solid on a piece of paper as it is separated and identify it. Place the remaining liquid in the test tube. INSTRUCTOR'S INITIALS_____.

CLEAN YOUR WORK STATION AND RETURN EVERYTHING TO ITS PROPER PLACE. INSTRUCTOR'S INITIALS_____.



SIMPLE DISTILLATION APPARATUS

* Place chip of glass or glass bead in test tube to avoid blow out.

Title: LAB--Elements, Compounds and Mixtures

Unit: Elements, Compounds and Mixtures

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe the differences between an element, a compound and a mixture.

Materials Required:

Test tube, bunsen burner, test tube holder, magnifying glass, striker, bar magnet, apron, eyeshield, triple beam balance, weighing paper, iron powder or filings, powdered sulfur.

Information:

All matter can be classified either as an element, a compound or a mixture. An ELEMENT is a substance that cannot be broken down into simpler substances by ordinary chemical means; Hydrogen, oxygen, iron, and sulfur are all examples of elements. A COMPOUND is a substance made up of two or more elements chemically combined. A compound, therefore, can be separated by chemical means. Pure water, iron ore, and butane are examples of compounds. A MIXTURE is a substance whose ingredients are not combined chemically. A mixture may, therefore, be separated by physical means. Air, salt and pepper, granite and soup are examples of mixtures.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. KEEP YOUR WORK AREA CLEAN. DO YOUR OWN WORK. PRACTICE SAFETY AT ALL TIMES.

1. Weigh 5.6 grams of iron powder (or filings). BE CERTAIN THAT THE BEAM BALANCE IS ZEROED-IN AND THAT YOU USE WEIGHING PAPER. DO NOT SPILL ANY OF THE MATERIALS.

2. Hold the bar magnet UNDER the weighing paper and CAREFULLY move it around.
   Is the iron attracted to the magnet?
   What is the color of the iron?
   Is iron an element, compound or mixture? Why?

3. Weigh 3.2 grams of powdered sulfur. Hold the bar magnet UNDER the weighing paper and CAREFULLY move it around.
   Is the sulfur attracted to the magnet?
   What is the color of the sulfur?
   Is sulfur an element, compound or mixture? Why?

Title: LAB--Elements, Compounds and Mixtures

PAGE TWO

4. Mix the iron and the sulfur together. Examine the material with a magnifying glass.

   Can you distinguish between the iron and sulfur particles?

5. CAREFULLY pass the magnet UNDER the paper. What happens? Is this an element, compound or mixture? Why?

6. Mix the iron and sulfur again and place into a clean, dry test tube. Using a test tube holder CAREFULLY heat the test tube and its contents. REMEMBER TO CIRCULATE THE TEST TUBE WHEN HEATING, AND POINT IT AWAY FROM YOURSELF AND ANY OTHER PERSON.

7. Heat until material begins to glow, then heat for a few minutes more.

8. IMMEDIATELY plunge the test tube into a stream of cold water to break the test tube.

9. Recover the remaining material. BE CAREFUL OF BROKEN GLASS. Examine the remaining material with the magnifying glass.

   What do you observe?

   How does it compare to the iron and sulfur in step 4?

10. Test the material with a magnet. What happens?
    How does this compare with the iron and sulfur in step 5?
    Is this an element, compound or mixture? Why?

CAREFULLY CLEAN UP YOUR WORK STATION. PLACE ALL MATERIALS AS INDICATED BY YOUR INSTRUCTOR. INSTRUCTOR'S INITIALS_____.

Title: LAB--Double Replacement Reactions

Unit: Elements, Compounds and Mixtures

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe double replacement reactions and to practice formula and equation writing and balancing.

Materials Required:

Test tube rack, 10 test tubes, test tube brush, beaker (or other container for collecting precipitates), eye shield, apron, solutions of aluminum chloride, sodium hydroxide, barium chloride, iron (II) sulfate, nickel nitrate, copper (II) chloride, lead (II) nitrate, calcium sulfate, and chromium sulfate (all solutions should be 0.1 M, except for the sodium hydroxide which is dilute or 6 M), solubility table.

Information:

A reaction in which the metals (positive elements) present in two components change places to form two new compounds is called a DOUBLE REPLACEMENT REACTION. The general form of a double replacement reaction is represented by

$$AB + CD \rightarrow CB + AD$$

The elements A and C exchange places to form the new compounds AD and CB.

In this lab, two water solutions will be mixed and a double replacement reaction will take place. Evidence of this will be the production of a precipitate. The precipitate forms because one of the two products is insoluble. To determine which product it is, a SOLUBILITY TABLE will be used. The product that is the precipitate is indicated in the equation by a downward pointing arrow ( ). For example, if the new compound AD were the precipitate, the general form of the reaction would become

$$AB + CD \rightarrow CB + AD\downarrow$$

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. DO YOUR OWN WORK. KEEP WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Set up ten test tubes in the test tube rack. Number them for identification, 1 thru 10.

Title: LAB--Double Replacement Reactions

2. Add two milliliters of the solution indicated to the proper test tube. REMEMBER TO HANDLE ALL SOLUTIONS CAREFULLY. CLEAN ANY SPILLS IMMEDIATELY.

Test Tube	Solution
#1	Aluminum Chloride
#2	Sodium Hydroxide
#3	Barium Chloride
#4	Iron (II) Sulfate
#5	Iron (II) Sulfate
#6	Sodium Hydroxide
#7	Nickel Nitrate
#8	Sodium Hydroxide
#9	Copper (II) Chloride
#10	Sodium Hydroxide

3. Add the contents of test tube #1 to that of test tube #2. Observe the reaction. Note and record the color of the precipitate, if one appears. INSTRUCTOR'S INITIALS_____.

4. Repeat step 3 for test tubes 3 and 4, 5 and 6, 7 and 8, 9 and 10. Remember to record your observations in each case.

5. Carefully clean out the test tubes. Dump the precipitate in a beaker or other container designated by your instructor. DO NOT DUMP INTO SINK. Wash and rinse test tubes thoroughly. INSTRUCTOR'S INITIALS_____.

6. Set the ten cleaned test tubes in the test tube rack and again identify them 1 thru 10.

7. Add two milliliters of the new solution indicated to the proper test tube. REMEMBER TO BE CAREFUL.

Test Tube	Solution
#1	Lead (II) Nitrate
#2	Iron (II) Sulfate
#3	Calcium Sulfate
#4	Lead (II) Nitrate
#5	Calcium Sulfate
#6	Barium Chloride
#7	Chromium Sulfate
#8	Barium Chloride
#9	Chromium Sulfate
#10	Sodium Hydroxide

8. Repeat steps 3 thru 5 for the new set of solutions.

9. Carefully clean the test tubes. REMEMBER NOT TO DUMP THE PRECIPITATES IN THE SINK. Return test tubes to the test tube rack and place in an inverted position so they may dry. INSTRUCTOR'S INITIALS _____.

10. On a separate piece of paper, write the complete and balanced equation for each reaction that occurred. Be certain that all formulas are balanced and that the color of the precipitate is indicated. Don't forget to indicate the precipitate in the equation. The first reaction will be discussed for you as an example:

    When you mixed aluminum chloride with sodium hydroside a white precipitate should have resulted. A reaction occurred, but what was the precipitate? Consult a Solubility Table. You will note that the new compounds (as evidenced by the completion of a reaction) are aluminum hydroside and sodium chloride. Sodium chloride is soluable in water so it is not the precipitate. On the other hand, aluminum hydroxide is insoluable in water and, therefore, it must be the precipitate. On the sheet you hand in, you should have written down

    aluminum chloride + sodium hydroxide → aluminum hydroxide + sodium chloride

    $$AlCl_3 + 3NzOH \rightarrow 3NzCl + Al(OH)_3\downarrow \quad \text{(white)}$$

Do this for each reaction.

Title: LAB--Double Replacement Reactions

Solubilities of Some Common Salts

	ACETATE	BROMIDE	CARBONATE	CHLORATE	CHLORIDE	CHROMATE	HYDROXIDE	IODIDE	NITRATE	OXIDE	PHOSPHATE	SILICATE (ORTHO)	SULFATE	SULFIDE
	$C_2H_3O_2$	Br	CO_3	ClO_3	Cl	CrO_4	OH	I	NO_3	O	PO_4	SiO_4	SO_4	S
Aluminum (Al)	S	S		S	S		HS	S	S	HS	HS	HS	S	HS
Ammonium (NH_4)	S	S	S	S	S	S	S	S	S		S		S	S
Barium (Ba)	S	S	HS	S	S	HS	S	S	S	HS	HS	HS	I	S
Calcium (Ca)	S	S	HS	S	S	SS	S	S	S	SS	HS	HS	SS	SS
Cobalt (Co)	S	S	HS	S	S	HS	HS	S	S	HS	HS	HS	S	HS
Copper (Cu)	S	S	HS	S	S	S	HS	S	S	HS	HS	HS	S	HS
Iron (ferric) (Fe^{+++})	S	S		S	S	S	HS	S	S	HS	HS	HS	S	HS
Iron (ferrous) (Fe^{++})	S	S	HS	S	S		HS	S	S	HS	HS	HS	S	HS
Lead (Pb)	S	SS	HS	S	SS	HS	HS	SS	S	HS	HS	HS	I	HS
Magnesium (Mg)	S	S	HS	S	S	S	HS	S	S	HS	HS	HS	S	HS
Manganese (Mn)	S	S	HS	S	S	S	HS	S	S	HS	HS	HS	S	HS
Mercury (mercuric) (Hg^{++})	S	S	HS	S	S	SS		HS	S	HS	HS		SS	I
Mercury (mercurous) (Hg^{+})	S	HS		S	HS	HS		HS	S	HS	HS		SS	
Nickel (Ni)	S	S	HS	S	S	HS	HS	S	S	HS	HS	HS	S	HS
Potassium (K)	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Silver (Ag)	S	I	HS	S	I	HS		I	S	HS	HS		SS	HS
Sodium (Na)	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Tin (stannous) (Sn)	S	S			S	HS	HS	S		HS	HS		S	HS
Zinc (Zn)	S	S	HS	S	S	S	HS	S	S	HS	HS	HS	S	HS

S—the salts are soluble in water.
HS—the salts are insoluble in water, but are soluble in either HCl or HNO_3 or in both.
I—the salts are insoluble in water and in acids.
SS—the salts are slightly soluble in water and slightly or readily soluble in acids.

Title: LAB--Single Replacement Reactions

Unit: Elements, Compounds and Mixtures

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with single replacement reactions, to prepare an activity series, and to practice equation writing and balancing.

Materials Required:

Strips (about 1 x 1 cm) of sheet copper, lead, and zinc, emery cloth or sandpaper, test tube rack, 6 test tubes, eye shield, apron, 0.1 M solutions of copper (II) nitrate, lead (II) nitrate, magnesium sulfate, silver nitrate, and dilute sulfuric acid.

Information:

Chemical reactivity of elements varies to a large degree. Some are so reactive that they are never found in the free or uncombined state in nature. Others are nearly inert and only under special conditions will they react with other elements.

ACTIVITY SERIES OF METALS

INCREASES ACTIVITY ↑ / ↓ DECREASES ACTIVITY

	lithium	Li
	potassium	K
	calcium	Ca
	sodium	Na
	magnesium	Mg
	aluminum	Al
	manganese	Mn
	zinc	Zn
	chromium	Cr
	cadmium	Cd
	iron	Fe
	cobalt	Co
	nickel	Ni
	tin	Sn
	lead	Pb
**	hydrogen	H
	antimony	Sb
	copper	Cu
	mercury	Hg
	silver	Ag
	platinum	Pt
	gold	Au

**although hydrogen is not a metal, it often acts like one.

The REACTIVITY of an element is related to its tendency to lose electrons (oxidize) or gain electrons (reduce). In principle it is possible to arrange nearly all elements into a single series according to their reactivities. A series of this type, known as an ACTIVITY or ELECTROMOTIVE or ELECTROCHEMICAL SERIES, indicates which free elements are capable of replacing other elements from their compounds.

The relative ability of metallic elements to form ions in aqueous solutions depends on the ease with which the element loses valence electrons. Since metals are defined as elements that tend to lose electrons, the more metallic the element, the less the tendency of its ions in solution to acquire electrons and become a free metal.

Some general principles for use of the Activity Series: 1) Activity of metals decreases from top to bottom; 2) Free metal can displace metal ions in solution which lie below the free metal in the series; and, 3) the closer the elements are to each other in the series, the less reactive they are.

Title: LAB--Single Replacement Reactions

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The general form of a single replacement reaction is represented by

$$A + BC \rightarrow B + AC$$

The more active element, element A, replaces element B from the compound BC. If element B is more active than element A, however, no reaction occurs and the equation remains

$$A + BC \rightarrow A + BC \quad \text{(no reaction)}$$

In contrast to double replacement reactions, single replacement reactions involve changes in oxidation number (valence) and are also classified as OXIDATION-REDUCTION REACTIONS.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. KEEP WORK STATION CLEAN AND IN ORDER AT ALL TIMES. DO YOUR OWN WORK. PRACTICE SAFETY AT ALL TIMES.

1. Obtain THREE pieces of sheet zinc, TWO of copper, and ONE of lead. Rub the strips with emery cloth or sandpaper to expose fresh metal surfaces.
2. Place six clean test tubes in a rack and position-code or number them (1 thru 6).
3. Add the following items to each test tube. HANDLE ALL SOLUTIONS WITH CAUTION. OBSERVE ALL SAFETY PRECAUTIONS:

   Tube 1: about 5 ml. silver nitrate and copper strip
   Tube 2: about 5 ml. copper (II) nitrate and lead strip
   Tube 3: about 5 ml. lead (II) nitrate and zinc strip
   Tube 4: about 6 ml. magnesium sulfate and zinc strip
   Tube 5: about 5 ml. dilute sulfuric acid and copper strip
   Tube 6: about 5 ml. dilute sulfuric acid and zinc strip

4. Observe the contents of each test tube carefully and record any evidence of a chemical reaction. With some combinations used in this lab, the reactions may be slow and difficult to detect. If there is no immediate evidence of a reaction allow the tube to stand aside for 10 to 15 minutes, then reexamine it. Evidence of a reaction will be the evolution of a gas or the appearance of a metallic deposit on the metal strip. Under "EVIDENCE OF REACTION", describe any reaction. If no reaction takes place, write "NONE". Under "BALANCED EQUATION", complete the equation and be certain that it is balanced.

Title: LAB--Single Replacement Reactions

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TEST TUBE	EVIDENCE OF REACTION	BALANCED EQUATION
EX.	Copper deposit on iron	$Fe + CuSO_4 \rightarrow Cu + FeSO_4$
1.		
2.		
3.		
4.		
5.		
6.		

5. Based on your observations in step 4, arrange all five of the metals (copper, lead, magnesium, silver, and zinc) in an activity series, listing the most active first:

(1)_____

(2)_____

IRON (from example)

(3)_____

HYDROGEN

(4)_____

(5)_____

How did your activity series compare to the one that was presented in the information portion of this lab?

6. CLEAN UP YOUR WORK STATION. DO NOT DUMP ANY OF THE METAL SAMPLES INTO THE SINK (PLACE THEM IN THE AREA DESIGNATED BY YOUR INSTRUCTOR). INSTRUCTOR'S INITIALS_____.

Title: LAB--Flame Test

Unit: Elements, Compounds and Mixtures

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To identify certain metals by the color they impart to a flame.

Materials Required:

0.5 M test solutions of barium chloride, barium nitrate, calcium hydroxide, calcium sulfate, lithium chloride, lithium nitrate, potassium chloride, potassium nitrate, sodium chloride, sodium nitrate, strontium chloride and strontium nitrate, cleaning solution (dilute HCl, 1:4), platinum wire, bunsen burner, striker, 12 test tubes, test tube rack, 100 ml. beaker, cobalt blue glass plate, apron, eye shield.

Information:

When attempting to identify small quantities of material, one method used is the FLAME TEST. This test is based on the fact that certain elements produce a characteristic color when heated in a flame. Each color represents a specific quantity of energy in the form of light. Electrons of different atoms require different amounts of energy to jump to a higher energy level. This energy is given off as different colors of light as the electrons fall back to their former (lower) energy level.

There are various commercial materials that are on the market today which are used to produce colored flames for a wood fire in a fireplace. Other commercially prepared "synthetic" logs produce multicolored flames when burned. In either case, the colors are produced by particular elements in the compounds that make up the materials. Another excellent example of this is the colorful July 4th fireworks display. Ever wonder where all the colors came from?

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Set up bunsen burner and adjust the flame. The flame should have a blue inner cone with no yellow.

2. Carefully place some cleaning solution in the beaker. REMEMBER, IT CONTAINS ACID AND SHOULD NOT BE SPLASHED OR SPILLED.

3. Carefully pour about 4 milliliters of barium chloride into a clean test tube and place it in the test tube rack. You will repeat this for each solution being tested, so be certain to position or number code each test tube so you can identify each solution.

Title: LAB--Flame Test

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4. Clean the platinum wire by dipping it first into the cleaning solution and then holding it in the colorless flame of the burner. BE CAREFUL OF THE FLAME. Repeat this cleaning process until the wire imparts NO COLOR to the flame.

5. Dip the tip of the clean platinum wire in the barium chloride solution in the test tube. Hold the wire in the flame, being careful to heat only the tip of the wire. Observe the color of the flame just above the wire. Record your observations in the chart. INSTRUCTOR'S INITIALS _____.

6. Clean the platinum wire as directed in step 4. Repeat step 5 for each of the test solutions. REMEMBER TO CLEAN THE WIRE AFTER EACH TEST AND RECORD YOUR OBSERVATIONS IN THE CHART.

7. Since two salts may be present in the same solution, the color of one flame may obscure the other. Repeat the flame test for each of the sodium and potassium solutions, but use the cobalt blue glass plate to observe the color of the flame. Record your observations in the chart. Did you notice any differences? Explain here.

8. Mix a sodium and potassium solution together. Which two did you mix?

   Repeat the flame test. First view it normally and then with the cobalt blue glass plate. Record observations in the chart. What differences did you note? Explain here.

CLEAN UP YOUR WORK STATION. DISPOSE OF ALL SOLUTIONS AS DIRECTED BY YOUR INSTRUCTOR. INSTRUCTOR'S INITIALS_____.

Title: LAB--Flame Test

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COMPOUND	COLOR OF FLAME (NORMAL VIEWING)	COLOR OF FLAME (COBALT GLASS)	ELEMENT CAUSING COLOR	COMMENTS
BARIUM CHLORIDE		———		
BARIUM NITRATE		———		
CALCIUM HYDROXIDE		———		
CALCIUM SULFATE		———		
LITHIUM CHLORIDE		———		
LITHIUM NITRATE		———		
POTASSIUM CHLORIDE				
POTASSIUM NITRATE				
SODIUM CHLORIDE				
SODIUM NITRATE				
STRONTIUM CHLORIDE		———		
STRONTIUM NITRATE		———		
MIXTURE OF SODIUM AND POTASSIUM _____				

Title: LAB--Borax Bead Test

Unit: Elements, Compounds and Mixtures

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To identify certain metals by the color they impart to a borax bead.

Materials Required:

Powdered borax (hydrated sodium tetraborate), chromium (III) chloride, chromium (III) sulfate, cobalt (II) nitrate, cobalt (II) oxide, iron (II) chloride, iron (II) sulfate, manganese (II) chloride, manganese (II) sulfate, nickel (II) chloride, nickel (II) sulfate, bunsen burner, striker, platinum wire, evaporating dish, 2 watch glasses, apron, eyeshield.

Information:

Borax (hydrated sodium tetraborate, $Na_2B_4O_7 10 \cdot H_2O$) loses water of hydration when heated strongly and fuses to form a colorless glassy solid. Tiny amounts of certain materials heated with borax produce a colored bead. The characteristic color may be used to identify the metal.

Colored glass and precious stones owe their color to the metals they contain.

Procedure:

FOLLOW ALL DIRECTIONS CAREFULLY. DO YOUR OWN WORK. KEEP YOUR WORK AREA CLEAN AND IN ORDER. PRACTICE SAFETY AT ALL TIMES.

1. Bend tip of platinum wire so it has a loop of about 3 millimeters in diameter.
2. Set up bunsen burner and adjust it so it has a clean flame.
3. Place a very small mound of borax on a watch glass.
4. Heat the platinum wire in the flame of the burner until white hot. BE CAREFUL OF THE FLAME. Quickly dip the wire into the powdered borax. Return the wire to the upper portion of the flame (the oxidizing portion) until the borax has melted to a clear glass. AVOID USING TOO MUCH BORAX AS IT WILL FALL OFF THE WIRE.
5. Place a few specks of chromium (III) chloride on the second watch glass.

Title: LAB--Borax Bead Test

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6. Reheat the bead on the platinum wire and, WHILE HOT, touch it to a speck of chromium (III) chloride. Reheat the bead again in the upper portion of the burner flame. The bead should be colored and transparent. If it is black or opaque too much was used and a new bead must be made. Record your observations in the chart. INSTRUCTOR'S INITIALS_____.

7. To remove the borax bead, heat the wire strongly in the burner flame and then move it over the evaporating dish, striking your hand holding the wire over the fist of your other hand. BE CAREFUL OF HOT MATERIALS. Most of the bead will fall into the evaporating dish. Any additional traces can be removed by heating the wire and plunging it into cold water. The remaining fragments can be rubbed off between the fingers.

8. Clean the platinum wire by making a new borax bead and shaking it off as described in step 7 into the evaporating dish. Repeat as necessary to remove all traces of the colored bead from previous test.

9. Repeat the steps for testing the remaining samples. REMEMBER TO ONLY USE A SPECK OF EACH SAMPLE AT ONE TIME. HANDLE ALL MATERIALS CAREFULLY. RECORD YOUR OBSERVATIONS IN THE CHART.

CLEAN UP YOUR WORK AREA. DISPOSE OF ALL MATERIALS AS INDICATED BY YOUR INSTRUCTOR. PLACE ALL EQUIPMENT IN THE PROPER LOCATION.
INSTRUCTOR'S INITIALS_____.

Title: LAB--Borax Bead Test

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COMPOUND	COLOR OF BEAD	ELEMENT CAUSING BEAD COLOR	COMMENTS
CHROMIUM (III) CHLORIDE			
CHROMIUM (III) NITRATE			
COBALT (II) NITRATE			
COBALT (II) OXIDE			
IRON (II) CHLORIDE			
IRON (II) SULFATE			
MANGANESE (II) CHLORIDE			
MANGANESE (II) SULFATE			
NICKEL (II) CHLORIDE			
NICKEL (II) SULFATE			

Title: LAB--Solutions and Suspensions

Unit: Elements, Compounds and Mixtures

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe the differences between solutions and suspensions and learn some factors that affect the rate of solution.

Materials Required:

Calcium carbonate (precipitated chalk), sugar, potassium dichromate cyrstals, copper sulfate crystals, water, 3 100 ml. beakers, 4 test tubes, test tube rack, mortar and pestle, bunsen burner, striker, stirring rod, test tube holder, apron, eyeshield, triple beam balance.

Information:

A solution is a uniform mixture of a solute and a solvent which can be made in varying proportions. The SOLUTE is the substance dissolved by the liquid SOLVENT.

A suspension is a mixture of a liquid and a solid, but the solid does not dissolve. Instead, the solid remains suspended in the liquid for some time.

Some solutes have rapid dissolving rates, while others do not. There are three ways in which one can help a solid solute go into solution in a liquid.

1. Break, crush or grind the solid solute into smaller pieces.
2. Shake, stir or mechanically agitate the solute and solvent together.
3. Apply heat to the solution or warm the liquid solvent.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR WORK STATION CLEAN AND IN ORDER. PRACTICE SAFETY AT ALL TIMES.

PART ONE.....SOLUTIONS AND SUSPENSIONS

1. Fill the first beaker, two-thirds full, with water.
2. Add about 4 grams of calcium carbonate (precipitated chalk) to the water and stir vigorously.
   Did the chalk dissolve?

3. Hold the mixture up to the light.
How does it appear? Is it clear or cloudy?

4. Allow the mixture to stand for a few minutes.
Does the chalk settle to the bottom? Explain.

5. Fill the second beaker, two-thirds full, with water.

6. Add about 4 grams of sugar to the water and stir vigorously.
Does the sugar dissolve?

7. Hold the mixture up to the light.
How does it appear? Is it clear or cloudy?

8. Allow the mixture to stand for a few minutes.
Does the sugar settle to the bottom? Explain.

9. Fill the third beaker, two-thirds full, with water.

10. Add about 4 grams of potassium dichromate crystals to the water and stir vigorously.
What is the color of the solution?

11. Hold the mixture up to the light.
How does it appear? Is it clear or cloudy?
Is the color uniform throughout the solution?

12. Allow the mixture to stand for a few minutes.
Does the potassium dichromate settle to the bottom? Explain.

INSTRUCTOR'S INITIALS_____.

PART TWO.....FACTORS AFFECTING THE RATE OF SOLUTION

1. Place four test tubes in the test tube rack and fill them halfway with water.

2. Select four crystals of copper sulfate. Try to have them all be about the same size.

3. Drop one crystal into the first test tube with water and allow it to stand.

4. Drop another crystal into the second test tube. Place your thumb over the mouth of the tube and shake vigorously.
Does this shaking increase the rate of dissolving the copper sulfate?

5. Grind another crystal to a powder. Use the mortar and pestle. Add this powder to the third test tube and shake vigorously.
Does the grinding help increase the rate of dissolving?

6. Grind the last crystal to a powder using the mortar and pestle. Warm the water in the fourth test tube with the bunsen burner. REMEMBER TO USE THE TEST TUBE HOLDER. Add the powder to this test tube and shake vigorously. BE CAREFUL OF THE HOT TEST TUBE AND WATER--It was only to be warm.
   Does warming the water increase the rate of dissolving?
   Compare what happened in step 4 (using cold water) to what happened in this step (using warm water).

   Compare what you did in this part of the lab. What generalizations can you make?

   INSTRUCTOR'S INITIALS_____.

CLEAN UP YOUR WORK STATION. BE CERTAIN THAT EVERYTHING IS IN ITS PROPER PLACE. INSTRUCTOR'S INITIALS_____.

ACIDS, BASES AND SALTS

Title: LAB--Indicators for Acids and Bases

Unit: Acids, Bases and Salts

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To prepare indicator solutions from domestic materials and observe their reactions with acids and bases.

Materials Required:

Red (purple) cabbage, tea bags, water, dilute acetic acid, dilute ammonium hydroxide, bunsen burner, ring stand, ring, wire gauze, asbestos mitts or gloves, eye shield, apron, 3 test tubes, test tube rack, test tube brush, stirring rod, dropper or glass tubing, watch glass, 250 ml. beaker, 100 ml. graduated cylinder, striker.

Information:

Phenolphthalein is colorless in an acid and turns red in a base. A litmus solution will turn red in an acid and blue in a base. Both can be called an INDICATOR because they indicate the presence of an acid or a base. In a more specific sense, however, an indicator indicates when a specific solution has reached a certain pH value. Certain organic substances change color at definite pH values. Some of these substances are prepared in the lab. Others are of plant or animal origin. Domestic materials, like fruits and vegetables, contain chemical substances that act like indicators.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Set up the bunsen burner and ring stand apparatus for heating operations.

2. Add about 200 milliliters of water to a 250 ml. beaker and bring to a boil. Turn off burner.

3. Place a tea bag in the beaker and prepare a "cup" of tea. When a good color is reached, discard the tea bag.

4. Pour the tea into each of three clean test tubes. REMEMBER TO HANDLE HOT LIQUIDS CAREFULLY. Fill about one-third of each. Do not discard the tea.

5. Identify the test tubes by position or number (1 thru 3) coding. Add the substances as indicated. REMEMBER TO HANDLE ALL SOLUTIONS CAREFULLY.

Test tube #1 add about 4 milliliters of dilute acetic acid
Test tube #2 add about 4 milliliters of dilute ammonium hydroxide
Test tube #3 add NOTHING--this will be the standard

6. Compare the three test tubes. Note the color changes. What happened when acid was added to the tea?

   What happened when a base was added to the tea?

7. To the contents of test tube #1, add some ammonium hydroxide. Did the color change? Can you explain why?

8. To the contents of test tube #2, add some acetic acid. Did the color change? Can you explain why?

9. Place a few drops of ammonium hydroxide on a watch glass. Place the watch glass on a piece of white paper for a background. Add some tea that you saved in the beaker, a few drops, and note the color change. What occurred?

10. Wash and clean the watch glass. Repeat step #9 with a few drops of acetic acid. What occurred?

    What generalizations can you make concerning the use of tea as an indicator?

11. Wash and clean all the glassware. INSTRUCTOR'S INITIALS_____.

12. Break up a red (purple) cabbage leaf and pack it into the 250 ml. beaker.

13. Add about 50 milliliters of water to the beaker, and bring to a boil. Boil for about 15 or 20 minutes until the liquid is deep purple in color. Turn off the burner.

14. CAREFULLY decant the liquid into three clean test tubes, filling each one about one-third. DO NOT DISCARD ANY OF THE JUICE.

15. Repeat steps 5 thru 10, using cabbage juice as the indicator. What were your observations?

16. Look up and report on at least FIVE indicators. Identify the indicator, its color change, and its pH range. Turn in the report as directed by your instructor.

CLEAN UP YOUR WORK STATION. PLACE ALL EQUIPMENT AS DIRECTED BY YOUR INSTRUCTOR. INSTRUCTOR'S INITIALS_____.

Title: LAB--Testing Acids and Bases and Determining pH

Unit: Acids, Bases and Salts

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with various tests for acids, bases, and pH and to utilize these tests.

Materials Required:

100 ml. beakers (enough for each of the samples to be tested), watch glass, glass tubing or dropper, stirring rod, red litmus paper, blue litmus paper, phenolphthalein solution, methyl orange solution, universal indicator solution, pH paper, pH meter, samples to be tested (e.g., ammonia, lemon juice, lime juice, lime water, vinegar, club soda, baking soda, baking powder, salt water, sugar water, tap water, hydrogen peroxide, drain cleaner, household bleach, buttermilk, shampoo, liquid soap, pickle juice, etc.), apron, eye shield.

Information:

A substance in solution which yields hydronium (hydrogen) ions is called an acid. One which yields hydroxyl (hydroxide) ions in solution is called a base. A salt is a compound formed when the positive ions from a base and the negative ions from an acid react.

Generally speaking, an indicator is a substance that changes color in an acid or a base. For example, red litmus paper turns blue in a base. Blue litmus paper turns red in an acid. Another indicator, phenolphthalein, remains colorless in an acid and changes to red in a base. Methyl orange turns red in an acid and yellow in a base. Each indicator, changes color at a certain pH value (this will not be specifically covered in this lab).

pH is a symbolism for expressing hydrogen ion concentration. This measures the relative strength of a substance, not merely whether it is an acid or base. A pH of 0 represents a very strong acid, and a pH of 14 represents a very strong base. A pH value of 7 is considered neutral.

The pH of a substance may be determined by testing with pH paper, a universal indicator, or with a pH meter. When using the various pH papers, the resulting color of the test strip is compared to a color chart to determine the pH value. When a universal indicator is used, the color that the solution turns is compared to a standard. In this lab, the universal indicator has the following standard.

		orange		green		indigo	
COLOR:	red		yellow		blue		violet
pH:	4	5	6	7	8	9	10

Title: LAB--Testing Acids and Bases and Determining pH

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When a pH meter is used, the resulting pH of a substance is read directly on the dial of the meter.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. KEEP YOUR WORK STATION CLEAN AND IN ORDER. PRACTICE SAFETY AT ALL TIMES.

1. Place watch glass on white paper (to help distinguish colors). Place one strip each of red litmus, blue litmus and pH paper on watch glass (remember to keep them separated).

2. Secure a sample to be tested. With a stirring rod, dip into the sample and then rub it on the red litmus paper. Note and record the result. Wash and dry the stirring rod and repeat the test with the blue litmus paper and then the pH paper. REMEMBER TO HANDLE ALL SUBSTANCES BEING TESTED WITH CARE.

3. Discard the test strips. DO NOT DUMP INTO THE SINK. Wash and dry the watch glass.

4. With the glass tubing or dropper, place a few drops of the substance being tested on the watch glass. Add a drop or two of the phenolphthalein solution. Note and record the color. Wash and dry the watch glass and repeat the test with the methyl orange solution and then the universal indicator solution.

5. Repeat steps 1 thru 4 for all the substances being tested. INSTRUCTOR'S INITIALS_____.

6. Take the beaker in which the test substance has been placed and set the probes (electrodes) of the pH meter into the substance. Determine the pH value via the dial reading. Note and record the result.

7. Rinse and clean the probes of the meter and repeat step 6 for all the substances being tested. REMEMBER TO CLEAN THE PROBE AFTER EACH TEST.

8. Record all data in chart form.

9. Prepare a pH scale of all substances tested beginning with the most basic and ending with the most acidic.

CLEAN YOUR WORK STATION. PLACE EVERYTHING AS INDICATED BY YOUR INSTRUCTOR. INSTRUCTOR'S INITIALS_____.

Title: LAB--Testing Acids and Bases and Determining pH

INSTRUCTOR'S NOTES

Assign students to bring in materials from shop or home for testing.

Preparation of test solutions--

METHYL ORANGE.....

1 gram methyl orange
dilute with distilled water to 1 liter

PHENOLPHTHALEIN, 0.2%.....

2 grams phenolphthalein
mix with 600 milliliters ethanol
dilute with distilled water to 1 liter

UNIVERSAL INDICATOR.....

In 100 milliliters of 95% ethyl alcohol dissolve
0.005 grams thymol blue
0.125 grams methyl red
0.06 grams bromthymol blue
0.10 grams phenolphthalein
neutralize to green with dilute sodium hydroxide
dilute with distilled water to 200 milliliters.

COMMENTS:

Title: LAB--Solubility of a Salt

Unit: Acids, Bases and Salts

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe the effect of temperature on the solubility of a salt.

Materials Required:

Potassium nitrate, water, triple beam balance, test tube, 10 ml. graduated cylinder, thermometer, ring stand, ring stand clamp, bunsen burner, striker, graph paper, apron, eye shield.

Information:

The solubility of a salt in water generally varies with changes in temperature. The higher the temperature, the more salt that will dissolve in water.

In this lab you will determine the solubility of potassium nitrate at several temperatures. To achieve this you will simply determine the temperature at which various mixtures of potassium nitrate and water yield saturated solutions. In other words, when they begin to form precipitates. You should find that the higher the concentration of the salt, the higher the temperature must be before all the salt dissolves in the water.

The reason for this is that, as the temperature increases, the water molecules move further apart leaving more room for the salt to dissolve in the water. As the temperature decreases, the water molecules move closer together and force the salt out of the solution and back into a solid precipitate.

Procedure:

FOLLOW ALL DIRECTIONS CAREFULLY. DO YOUR OWN WORK. KEEP YOUR WORK STATION CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Weigh 10 grams of potassium nitrate (KNO_3). Remember to use the weighing paper. Place this salt in test tube.

2. Add 5 ml of water to the contents of the test tube.

3. Clamp the test tube in a vertical position to the ring stand. Place the thermometer in the test tube.

4. Warm the mixture GENTLY AND CAREFULLY with the bunsen burner. Stir with the thermometer UNTIL THE SALE DISSOLVES. DO NOT HEAT MORE THAN IS NECESSARY (excessive evaporation of water will change the salt concentration).

Title: LAB--Solubility of a Salt

PAGE TWO

5. Allow solution to cool. Stir gently with thermometer. Note the temperature at which the salt starts coming out of the solution as a solid. This is known as the temperature of crystallization. Record the temperature in Chart A. INSTRUCTOR'S INITIALS_____.

6. Add 5 ml of water to the contents of the test tube (you now have 10 ml of water in the test tube.) Repeat steps 3 thru 5. Be certain to note and record the temperature in Chart A.

7. Again, add 5 ml of water to the test tube. Repeat steps 3 thru 5.

8. Once more, add 5 ml of water to the test tube and repeat steps 3 thru 5.

9. Finally, add 5 more ml of water to the test tube (you now have 25 ml of water in the test tube). Repeat steps 3 thru 5. INSTRUCTOR'S INITIALS_____.

10. Chart B gives the temperatures of crystallization under ideal conditions. This data is to be used for comparison with your experimental data.

11. Plot the data from this lab on graph paper. The temperature of crystallization will be the horizontal axis, while the concentration of potassium nitrate per 100 ml of water will be the vertical axis. Plot the data from both charts (A and B) on the same graph. Use color or line coding to distinguish between each curve.

12. On the reverse side of your graph paper, answer the following questions:

    A. Why must the test tube be heated gently?
    B. Compare your data with that under ideal conditions. Do they compare exactly? Why not?
    C. What happens to the temperature of crystallization as a solution becomes more concentrated?

CLEAN UP YOUR WORK STATION. BE CERTAIN THAT EVERYTHING IS RETURNED TO ITS PROPER LOCATION. INSTRUCTOR'S INITIALS_____.

Title: LAB--Solubility of a Salt

PAGE THREE

CHART A		
QUANTITY OF WATER	CONCENTRATION OF KNO_3 / 100ml H_2O	TEMPERATURE OF CRYSTALLIZATION
5ml	200g	
10ml	100g	
15ml	67g	
20ml	50g	
25ml	40g	

CHART B	
CONCENTRATION OF KNO_3 / 100ml H_2O	TEMPERATURE OF CRYSTALLIZATION
20.9g	10°C
31.6g	20°C
45.8g	30°C
63.9g	40°C
85.5g	50°C
110.0g	60°C
138.0g	70°C

Title: LAB--Use of Sulphuric Acid (H_2SO_4)

Unit: Acids, Bases and Salts

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORK DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To show how to compound sulphuric acid as an electrolyte for use in an auto battery.

Materials Required:

Hydrometer with specific gravity range from 1.0 to 2.0, One 1000 ml. graduate, One 1000 ml. beaker, apron, eye shield, Sulphuric Acid with specific gravity of 1.82 water.

Information:

This lab will be given in two parts. First part will show how the electrolyte is compounded by the use of a hydrometer. The second part will show the electrolyte compound by per cent.

The addition of sulphuric acid to water is very dangerous and must be done cautiously and slowly. Safety glasses must be worn. This addition is an example of an exotheric reaction which gives off large amounts of heat.

Either part of this lab may be used to produce the electrolyte for an auto battery. Part One uses the hydrometer method: Part Two uses percentage.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR WORK STATION CLEAN. PRACTICE SAFETY AT ALL TIMES. DO NOT THROW ANY MATERIAL IN SINK.

PART ONE:

1. In a 1000 ml graduate, place enough water so that you can read the hydrometer as it floats.

   The reading is _____

2. If possible, take a reading of the sulphuric acid.

   The reading is _____

Title: LAB--Use of Sulphuric Acid

PAGE TWO

3. Pour out approximately 500 ml of water from the 1000 ml graduate and slowly add the sulphuric acid.

   What is the condition of the graduate?

   _____

4. Continue to add the sulphuric acid allowing time for the container to cool somewhat, until the specific gravity, as indicated by your hydrometer reads 1.27 - 1.3.

5. This solution, when cooled, may be added to an acid lead cell battery.

PART TWO:

1. Measure out 732 ml of water into a 1000 ml beaker.

2. Measure 268 ml of sulphuric acid.

3. Slowly pour the 268 ml of sulphuric acid into the 732 ml of water.

4. Place the mixture into the 1000 ml graduate and take the hydrometer reading:

   _____

5. This is a 38% by weight solution of battery acid.

6. CLEAN WORK AREA. BE EXTREMELY CAREFUL OF ACID.
   INSTRUCTOR'S INITIALS_____.

HOME

CHEMISTRY

Title: LAB--Leavening

Unit: Home Chemistry

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with the leavening action of baking powder.

Materials Required:

2 test tubes, one0hole stopper, ring stand, ring stand clamp, delivery tube, watch glass, glass tubing or dropper, eye shield, apron, sodium bicarbonate (or baking soda), dilute (1:4) hydrochloric acid, limewater solution, potassium hydrogen tartrate (or cream of tartar), monocalcium phosphate, (or superphosphate), potassium aluminum sulfate (or alum), water, blue litmus paper, triple beam balance, 100 ml. graduated cylinder.

Information:

LEAVENING, or the rising of dough, is very important in baking. To make the baked product light and porous, bubbles of carbon dioxide must be generated and trapped in the dough.

In leavening bread, the carbon dioxide is produced by the fermentation of sugar. Yeast cells produce enzymes that start the fermentation, converting the sugar to alcohol and carbon dioxide. The alcohol is driven off by the heat of baking. The carbon dioxide gas gives the bread a porous composition. The resulting bread is easily chewed, more palatable and appetizing, and easily digested.

The leavening of cake is generally brought about by the carbon dioxide liberated when baking soda and an acid ingredient react. When baking soda is mixed with flour and other ingredients and sour milk is added, the lactic acid in the sour milk reacts with the baking soda and carbon dioxide gas is produced.

The lactic acid in sour milk varies, making it difficult to control the reaction to produce carbon dioxide gas. BAKING POWDER is used because it has the reacting substances in the correct proportions. Baking powder is a leavening agent that has 1) baking soda (a source of carbon dioxide gas); 2) an acid producing substance (such as calcium phosphate, cream of tartar, or alum); and, 3) a preservative such as corn starch (which keeps the mixture dry when exposed to air).

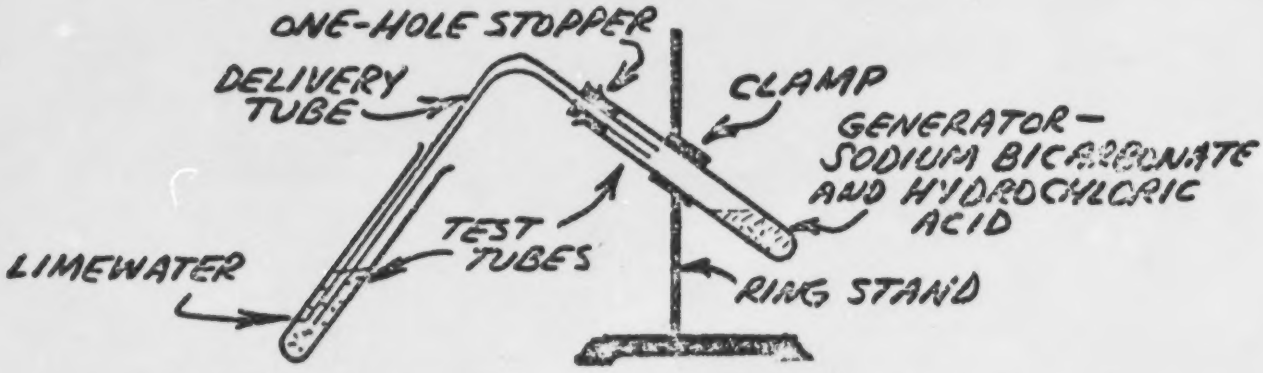
Procedure:

FOLLOW DIRECTIONS STEP-BY-STEP. DO YOUR OWN WORK. KEEP WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

Title: LAB--Leavening

PAGE TWO

1. Set up apparatus as indicated in the diagram.
2. In the test tube that is the generator, place 4.4 grams of sodium bicarbonate (baking soda). The formula for sodium bicarbonate is $NaHCO_3$.



3. Add a few drops of dilute hydrochloric acid, HCl. REMEMBER TO HANDLE THE ACID WITH CAUTION.
4. In the other test tube, place about 15 milliliters of lime-water. Lime water is a solution of $CA(OH)_2$. Be certain that the delivery tube is BELOW the level of the limewater.
   What is limewater used as a test for?
   What happened to the limewater?
   What does this indicate?
5. Hydrochloric acid is too corrosive to be utilized for leavening. Other acid substances are safer. Place a small amount of dry potassium hydrogen tartrate (cream of tartar), $KHC_4H_4O_6$, on a watch glass. Test with blue litmus paper.
   What happened to the litmus paper?
   What does this indicate?
6. Add a drop of water to the cream of tartar. Test the moistened portion with the blue litmus paper.
   What happened to the litmus paper?
   What does this indicate?
   What generalization can be made about these two tests?
7. Repeat steps 5 and 6 for monocalcium phosphate, $Ca(H_2PO_4)_2$.
   What were your observations?
8. Repeat steps 5 and 6 for potassium aluminum sulfate (alum). $KAl(SO_4)_2.12H_2O$. What were your observations?
9. Explain why a preservative, such as corn starch, is added to baking powder (i.e., why must the baking powder be kept dry?)

CLEAN YOUR WORK STATION. PLACE ALL EQUIPMENT AS DIRECTED BY YOUR INSTRUCTOR. INSTRUCTOR'S INITIALS_____.

Title: LAB--Leavening

INSTRUCTOR'S NOTES

To prepare limewater--

Place about 2 grams hydrated lime into a 250-milliliter beaker with water. Stir thoroughly for 1 minute. Filter into second container. The filtrate is clear limewater.

COMMENTS:

Title: LAB--Soapmaking

Unit: Home Chemistry

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To make crude soap and observe some of its characteristics.

Materials Required:

Distilled water, vegetable or animal fat or oil (e.g., cottonseed, coconut, olive, palm, castor oils, beef fat or tallow), sodium chloride, ethyl alcohol, kerosene, phenolphthalein, perfume (scent desired), evaporating dish, 2 test tubes, test tube rack, 2 beakers (100 ml. or larger), funnel, filter paper, bunsen burner, striker, glass stirring rod, ring stand, ring, wire gauze, soap mold, apron, eye shield, test tube brush.

Information:

Soap is made by the reaction of a vegetable or animal fat or oil with a base or hydroxide. A simple statement of the reaction is

FATS + STRONG BASE $\longrightarrow$ GLYCERIN + SOAP

Chemically, the fats are known as fatty acid esters (esters are organic compounds formed by the reaction between an alcohol and an acid). The three most important are palmatin $(C_{15}H_{31}COO)_3C_3H_5$. stearin $(C_{17}H_{35}COO)_3C_3H_5$, and olein $(C_{17}H_{33}COO)_3C_3H_5$. They are found in lard, tallow, olive oil, cottonseed oil, and other animal and vegetable fats or oils. The choice of fats or oils is determined partly by the cost of the materials.

The process of treating fats with bases or alkalies is called SAPONIFICATION. When hard soap is desired, lye or sodium hydroxide is used. When a soft or liquid soap is needed, potassium hydroxide is used.

If a soap has too much free alkali, it can be harmful to the skin, causing irritation. If it has too much fat, the lathering and cleansing power of the soap is reduced.

Procedure:

FOLLOW THE PROCEDURE STEP-BY-STEP. ALWAYS KEEP THE WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Place 10 cc. of oil into a clean evaporating dish and mix with it 10 cc. of ethyl alcohol.

Title: LAB--Soapmaking

PAGE TWO

2. HEAT GENTLY UNTIL HOT. USE CAUTION AS MIXTURE IS FLAMMABLE.

3. CAREFULLY add 10 cc. of 30% sodium hydroxide solution and STIR CONSTANTLY while CONTINUING TO APPLY HEAT, until you NO LONGER GET THE ODOR OF ALCOHOL.

4. Add 20 cc. of distilled water and stir until a UNIFORM MIXTURE is obtained.

5. Allow mixture in the evaporating dish to cool a little and pour it SLOWLY into a beaker containing 100 cc. of saturated sodium chloride solution. STIR CONTENTS OF BEAKER AS SOAP IS BEING ADDED. Explain what happens:

6. Filter the liquid off the soap. DO NOT PUNCH HOLE IN FILTER PAPER.

7. Add a drop of perfume to the soap and MOLD it into a small bar. Place bar in location designated by your instructor to allow it to set.

8. Place a small amount of soap in test tube HALF FULL OF WARM WATER and shake. Did any suds form?_____. SAVE THIS SOLUTION.

9. Place a few drops of kerosene in a test tube HALF FULL OF WATER and shake. Do the two liquids mix?_____. Explain what happens:

10. Add soap solution from STEP 8 to mixture from STEP 9, and shake. Explain what happens:

11. After the bar has set, test it for free alkali--Cut off a small piece and heat VERY GENTLY in an evaporating dish to drive off any water. Allow to cool. Test with a DROP of phenolphthalein. What occurs?

12. Wash your thumb and index finger with your soap. DO NOT WASH REST OF SKIN AS THIS IS CRUDE SOAP AND MAY BE IRRITATING. What do you notice or observe?

CLEAN THE WORK STATION. BE CERTAIN THAT EVERYTHING IS IN ORDER AS DIRECTED BY YOUR INSTRUCTOR. INSTRUCTOR'S INITIALS_____.

Title: LAB--Soapmaking

INSTRUCTOR'S NOTES

Saturated oils should be used for this lab to insure solid soap is formed.

Soap mold is used to shape the sample of soap. It can simply be made from a strip of heavy paper and stapled in a circular shape.

COMMENTS:

Title: LAB--Chemical Gardening

Unit: Home Chemistry

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become familiar with raising plants in nutrient solutions.

Materials Required:

Potassium dihydrogen phosphate, calcium nitrate, magnesium sulfate, manganese (II) sulfate, boric acid, copper (II) sulfate, zinc sulfate, iron (II) sulfate, water, commercial plant food or liquid fertilizer, salt water solution, sugar water solution, 500-ml. beakers (or pint size butter, whipped cream, or delicatessen container), wire screen (1/4" or 1/2" mesh), glass wool or excelsior, 100 ml. graduated cylinder, 1 liter graduated cylinder, triple beam balance, storage containers for solutions (gallon size glass or plastic jugs), seeds (flower or vegetable).

If Part Two is to be completed--add 2-inch plastic or clay pot, 12-inch plastic or clay pot, sand.

If Part Three is to be completed--add plastic dishpan (or utility tub), plastic bucket (or pail), plastic or rubber hose, 2 sets hose couplings, 3/8" gravel.

Information:

Soilless plant culture, chemical gardening, chemi-culture, or hydroponics all refer to the growing of plants in nutrient solutions or in growing mediums (other than coil) into which the nutrient solutions have been added. Nutrients are known to be essential for optimum plant development. The macronutrients include calcium, carbon, hydrogen, magnesium, nitrogen, oxygen, phosphorus and potassium. The micronutrients or trace elements include boron, chlorine, copper, iron, manganese, molybdenum, sodium, sulfur, and zinc. Some may recall the function of some of these nutrients, for example, nitrogen, N, is said to be the leaf maker; phosphates, P_2O_5, are considered the root maker; and potash, K_2O, is said to be the flower maker. Each element has a specific function and need.

Along with the proper nutrients, proper aeration, light, temperature and humidity is also important. Water quality and pH is also a consideration.

Soilless plant cultures have many advantages. Included are such things as superior appearance, better flavor, higher nutritive value, faster growth, better keeping qualities, freedom from diseases, larger yields, and so on. Perhaps most important,

Title: LAB--Chemical Gardening

however, is the fact that it can be carried on at any time (whether in or out of season) several crops can be grown during one year, and it can be carried out anywhere (good soil is not a requirement).

Since soil is not used, obviously, in soilless plant culture a growing medium is required. The function of a growing medium is simply to provide support for the roots and the plant and to hold some of the nutrients. This growing medium can include such materials as sand, glass wool, excelsior, sawdust, wood chips, straw, gravel, lava, etc.

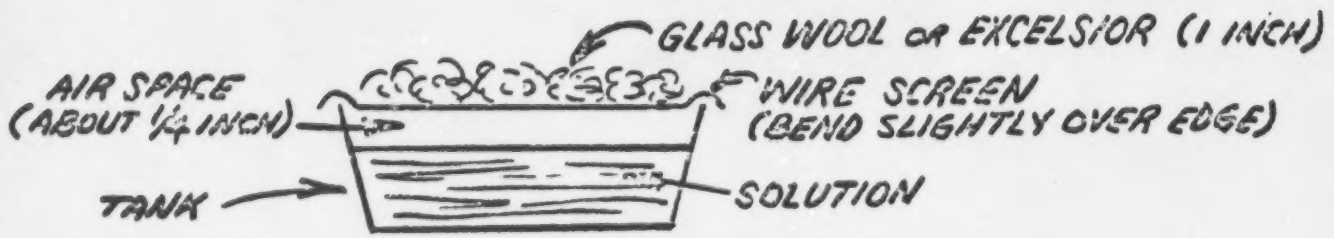
In order to engage in chemical gardening, one should gather all the information possible on the subject and study it carefully. For all intents and purposes, this lab will serve as an introduction to the subject. The prime consideration will be the preparation of tank cultures and the resulting study of the effect of various nutrients on plant growth and development. Included is an "extended demonstration" of a sand culture and a model of a hydrophonic system.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. KEEP THE WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

PART ONE.....TANK CULTURE

1. Prepare one tank or container, following the diagram below:



2. Prepare the solution indicated below for your group. Remember to check beam balance first and to use weighing paper.

SOLUTIONS FOR GROUPS

#1 Mix 2.3 grams potassium dihydrogen phosphate, KH_2PO_4, in 3780 milliliters of water.

#2 Mix 8.0 grams calcium nitrate, $Ca(NO_3)_2$, in 3780 milliliters of water.

Title: LAB--Chemical Gardening

#3 Mix 4.2 grams magnesium sulfate, $MgSO_4$, in 3780 milliliters of water.

#4 Mix 2.3 grams potassium dihydrogen phosphate, 8.0 grams calcium nitrate, and 4.2 grams magnesium sulfate in 3780 milliliters of water.

#5 Prepare the same solution as group #4 and add 15 milliliters of trace-element solution and 15 milliliters of iron solution.

#6 Mix 12 grams sodium chloride in 3780 milliliters of water (or use solution prepared by your instructor).

#7 Mix 18 grams sugar in 3780 milliliters of water (or use solution prepared by your instructor).

#8 Measure 3780 milliliters of plain tap water.

Trace Element Solution:

Manganese (II) Sulfate, $MnSO_4$	1.0 grams
Boric Acid, H_3BO_3	1.5 grams
Copper (II) Sulfate, $CuSO_4$	0.5 grams
Zinc Sulfate, $ZnSO_4$	0.5 grams
Water	946 milliliters

Iron Solution:

Iron (II) Sulfate, $FeSO_4$	5.0 grams
Water	946 milliliters

Nutrient Solution:

Potassium Dihydrogen Phosphate KH_2PO_4	2.3 grams
Calcium Nitrate, $Ca(NO_3)_2$	8.0 grams
Magnesium Sulfate, $MgSO_4$	4.2 grams
Trace-Element Solution	15 milliliters
Iron Solution	15 milliliters
Water	3780 milliliters

3. Place the seeds provided by your instructor, into the growing medium (the glass wool or excelsior). CAUTION: SOME SEEDS ARE COATED WITH A POISON. CLEAN HANDS THOROUGHLY AFTER HANDLING THEM.

4. Fill the tank with the solution that was prepared for your group. Be certain that your tank and solution container are marked for identification.

5. While the seeds in the tank culture are germinating, try to keep the temperature around 90° Fahrenheit, if possible. Once the seeds have sprouted and growth is well established, the temperature may be lowered (if possible, do not allow to go below 70° Fahrenheit).

Title: LAB--Chemical Gardening

PAGE FOUR

6. During ALL STAGES OF PLANT GROWTH, the chemicals MUST BE AERATED daily by vigorous stirring, using an air pump, etc. Why is this necessary?

7. Plants should be placed to receive maximum sunlight. Why is this necessary?

8. Water should be added to the solution in the tank during the week as necessary to maintain the level of 90% of the original solution.

   Why isn't more of the solution simply added to bring up the level?

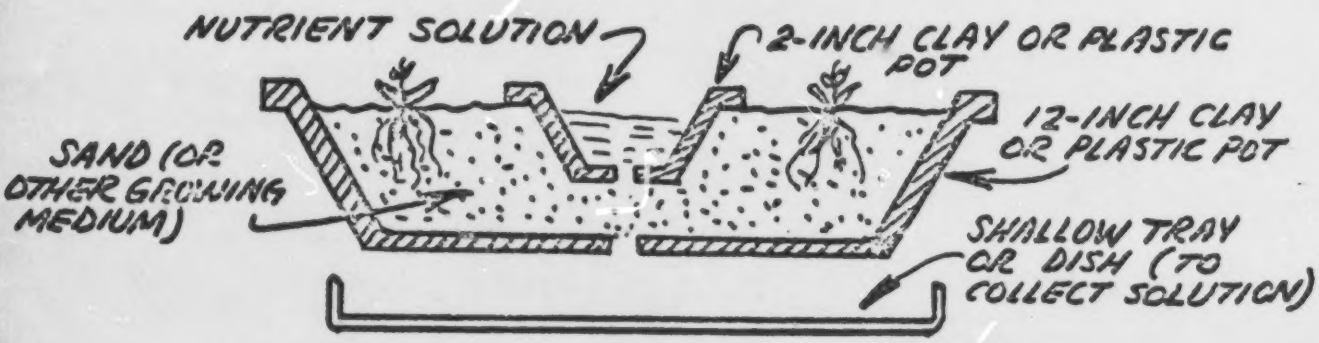
9. Every week to 10 days, replace the solution with a fresh one. Why?

10. Record all data and observations as to plant growth, addition of solutions, problems encountered. Compare the growth of your plants with those of the other groups. A report will be required at a later date as indicated by your instructor. INSTRUCTOR'S INITIALS_____.

BE CERTAIN THAT YOUR WORK STATION IS CLEAN AND IN ORDER.

PART TWO.....SAND CULTURE (OPTIONAL)

1. Set up sand culture as diagrammed below:

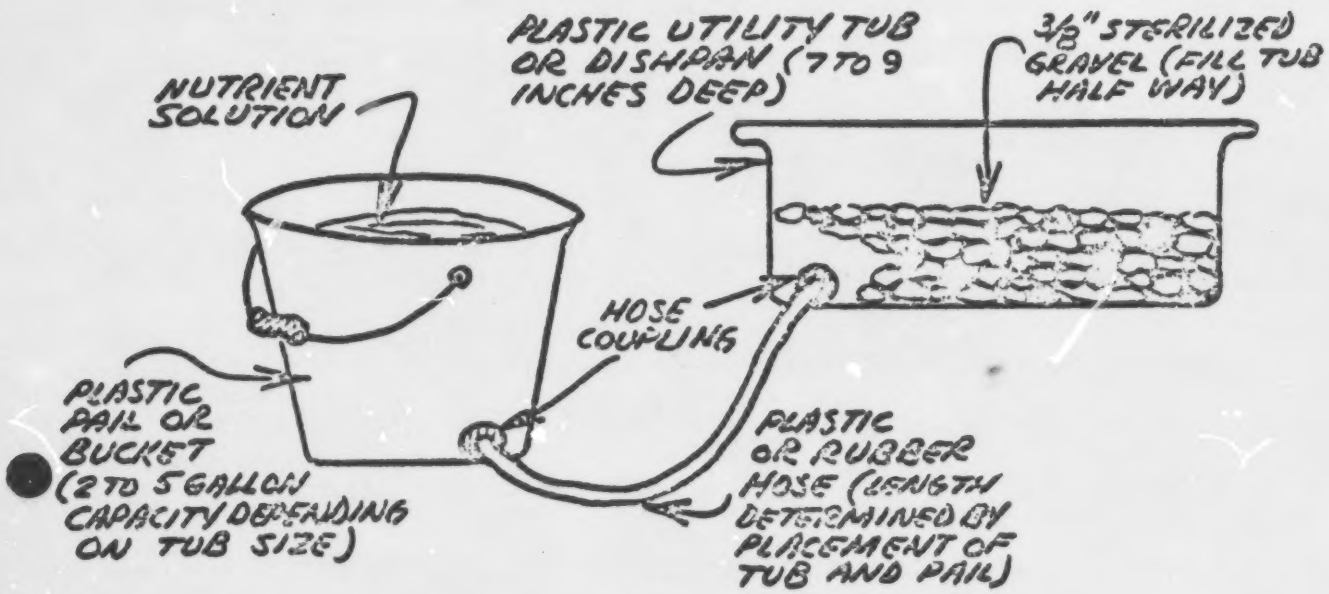

NUTRIENT SOLUTION
2-INCH CLAY OR PLASTIC POT
12-INCH CLAY OR PLASTIC POT
SAND (OR OTHER GROWING MEDIUM)
SHALLOW TRAY OR DISH (TO COLLECT SOLUTION)

2. Plant seeds or make transplant.
   Prepare the nutrient solution as specified in Part One of this lab. Pour into small pot. Collect into tray under large pot and reuse. Replenish solution as necessary.
   Note - An alternate method may be used: nutrient solution one day, plain water the next, etc.

Title: LAB--Chemical Gardening

PART THREE.....HYDROPONIC MODEL (OPTIONAL)

1. Set up apparatus as diagrammed below.


PLASTIC UTILITY TUB OR DISHPAN (7 TO 9 INCHES DEEP)
3/8" STERILIZED GRAVEL (FILL TUB HALF WAY)
NUTRIENT SOLUTION
HOSE COUPLING
PLASTIC PAIL OR BUCKET (2 TO 5 GALLON CAPACITY DEPENDING ON TUB SIZE)
PLASTIC OR RUBBER HOSE (LENGTH DETERMINED BY PLACEMENT OF TUB AND PAIL)

2. Plant seeds or make transplant.
Prepare nutrient solution as outlined in Part One of this lab. Place pail at a level lower than the tub and pour nutrient solution into the pail.

3. Lift pail higher than the tub and allow gravity to transfer the solution in the pail to the tub. Allow solution to rise in the tub until it is just below the surface of the gravel. Then lower pail to collect solution for reuse. The solution should drain back to the pail in less than an hour.

4. Repeat step 3 twice a day. Keep the volume of solution in the pail up to at least 90% of its original level by adding plain water when necessary.

5. Change solution completely every week or ten days (or when desired--depending on the experiment).

Title: LAB--Growth of Bacteria

Unit: Home Chemistry

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe the growth of bacteria from various sources.

Materials Required:

12 prepared petri dishes, apron, eye shield, incubator (over or other device to maintain required temperature).

Information:

Bacteria is present in air, water, soil and food. In fact it is almost everywhere except in a sterilized environment. They can be beneficial or harmful.

Harmful bacteria, such as germs or microbes, are called pathogenic bacteria. They invade plant and animal tissue. They include many diseases such as diphtheria, tuberculosis, and typhoid fever.

Nonpathogenic bacteria perform many useful functions and hold a place of enormous economic importance. They are responsible for decomposing refuse and improving the fertility of the soil. Without them we would have no sauerkraut, vinegar or cheeses.

One bacterium is so small (as small as 1/250,000 of an inch) that it cannot be seen with the naked eye. It would take over 1500 of them to cover a pin head. In a lab situation, they are grown in a specially prepared medium. Here they multiply to form colonies. These are visible as a tiny spot in the culture medium.

Procedure:

THIS LAB WILL BE PERFORMED AS A GROUP LAB. EACH INDIVIDUAL GROUP WILL INTRODUCE THE BACTERIA AS DESIGNATED BY THE INSTRUCTOR.

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP THE AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Secure one prepared petri dish. BE CERTAIN THAT IT REMAINS COVERED.

2. Introduce the bacteria as indicated below, depending on the assignment made by your instructor.

   A. KEEP CLOSED. This will serve as a control.
   B. Uncover. Expose to air in class or lab for 3 minutes. Cover

Title: LAB--Growth of Bacteria

C. Uncover. Expose to air in class or lab for entire lab period. Cover.
D. Uncover. Cough into dish. Cover.
E. Uncover. Touch fingertip to dish. Cover.
F. Uncover. Wipe fingers lightly across dish. Cover.
G. Uncover. Place strand of hair in dish. Cover.
H. Uncover. Touch a comb to dish. Cover.
I. Uncover. Touch a handkerchief to dish. Cover.
J. Uncover. Wipe floor with rag. Shake into dish. Cover.
K. Uncover. Scrape under fingernails into dish. Cover.
L. Uncover. Place penny or other coin in dish. Cover.

3. Mark or label petri dish for identification.

4. Place the dish in the area designated by your instructor. Here the bacteria will be incubated at normal body temperature (98.6°F) for 24 hours.

5. After the incubation period, examine the petri dish. What did you observe?

6. Compate all the petri dishes. How do they compare with the control?

7. Write a report concerning what you observed. Be certain to include your observations for your dish as well as that of all the others. Sketches of all the bacteria colonies will be welcomed. Try to draw some conclusions.

CLEAN YOUR WORK AREA. BE CERTAIN THAT EVERYTHING IS IN ITS PROPER LOCATION OR THAT IT IS DISPOSED OF PROPERLY.

INSTRUCTOR'S INITIALS_____.

Title: LAB--Growth of Bacteria

INSTRUCTOR'S NOTES

To prepare the petri dishes, refer to LAB--Preparation of Culture Media.

You may vary the introduction of bacteria depending on the group of students you have. For example, you may have one student wipe the fingers lightly across the dish right after reporting to lab. The next student washes the hand with water only and dries it and does the same thing. The next uses soap and water and does the same. The last uses a disinfectant and does the same.

You may assign students various locations around the school. Have them use sterile swabs and introduce possible samples from, for example, the locker room floor, the top of a machine, the hallway corridors, the gym floor, the shower room floor, the handles of tools, the dirt of the softball field, the cinders on the track, etc.

COMMENTS:

Title: LAB--Antiseptics and Disinfectants

Unit: Home Chemistry

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe the action of various antiseptics and disinfectants on the growth of bacteria.

Materials Required:

Prepared petri dishes (enough to test all the desired agents), apron, eye shield, incubation area.

Information:

It is possible to inhibit or limit the growth of bacteria by physically producing the conditions. Such conditions include: A) the lack of food, B) the lack of moisture (dryness), C) a very acid or alkaline medium, D) unfavorable temperature (freezing or heating at and above the boiling point of water), and E) the lack of darkness (direct sun rays and ultraviolet light).

Chemical agents in the form of antiseptic and disinfectant solutions can also be used to check the growth of and to destroy bacteria. The effectiveness of any solution depends on many factors including time, temperature, concentration, state of body fluids, etc.

Antiseptics are weak. They are used to check the growth of bacteria and may generally be used with safety on the skin or taken internally. On the other hand, disinfectants are strong and are used to kill bacteria. They are generally not used on the skin or inside the body. They are used to sterilize equipment, shower room floors, bathrooms, etc.

Procedure:

THIS LAB WILL BE PERFORMED AS A GROUP LAB. EACH INDIVIDUAL GROUP WILL INTRODUCE THE BACTERIA AND APPLY THE CHEMICAL AGENT AS DESIGNATED BY THE INSTRUCTOR.

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Secure a prepared petri dish. When your instructor tells you to, uncover the dish and expose it to the air in the class or lab for five (5) minutes. Your instructor will do the same thing. This dish will be the control. It will be covered after the 5 minutes period and no chemical agents will be introduced.

Title: LAB--Antiseptics and Disinfectants

2. When directed by your instructor, introduce the antiseptic or disinfectant by pouring or spraying a small amount into the dish. Immediately cover the dish.

3. Carefully place your petri dish in the incubation area. Be certain that it is marked or labeled for identification.

4. Check your dish and those of the other groups after a period of 24 hours. Note the growth of the colonies in each case.

5. Return the dish to the incubation area and repeat the check after a 48- and 72-hour incubation period. Note the growth of colonies again in each case.

6. Prepare a report describing your observations in this lab. Include a chart indicating the varying effectiveness of the antiseptics and disinfectants tested. Compare the growth and number of colonies with the control. Determine the most effective chemical agents used. Develop a wholesome conclusion.

CLEAN YOUR WORK STATION. REPLACE ALL EQUIPMENT AS DIRECTED. DISPOSE OF MATERIALS AS INDICATED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____.

Title: LAB--Antiseptics and Disinfectants

INSTRUCTOR'S NOTES

To prepare the petri dishes, refer to LAB--Preparation of Culture Media.

You may assign a student to bring a chemical agent from home to be tested. They may include various commercial spray disinfectants, Lysol, alcohol, iodine, mercurochrome, carbolic acid (phenol), boric acid, hydrogen peroxide, table salt, lysterine or other commercial mouth wash, chlorine, etc.

You may vary this lab to test the chemical agent against the bacteria it is supposed to control. For example, have a student rub his teeth with a sterilized cotton swab (or apply saliva to it). Have him impregnate the dish and then test a mouth wash. Another student could swab an area in a bathroom and test Lysol or Pinesol or other common bathroom disinfectant. Still another can test the cinders on a track and test Cinder Suds or other commercial antiseptic. The comparison to be made is whether or not the agent does the job effectively.

COMMENTS:

Title: LAB--Nutrients

Unit: Home Chemistry

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become familiar with the tests for certain nutrients.

Materials Required:

2 test tubes, bunsen burner, striker, ring stand, ring, ring stand clamp, pipe-stem triangle, crucible, evaporating dish, dropper, dextrose sugar (or corn syrup), potato (or other starchy food), butter (or other fatty food), lean meat (or other protein food), bread, Fehling's solution A and B (or Benedict's solution), tincture of iodine (or iodine dissolved in potassium iodide solution), concentrated nitric acid, ammonium hydroxide, unglazed writing paper, water.

Information:

Foods we eat contain usable substances called nutrients. They include carbohydrates (sugars and starches), fats or oils, proteins, minerals, vitamins, and water. Certain amounts of these nutrients are required for the proper health and functioning of our body.

Carbohydrates and fats are oxidized in the body to produce energy for body movement. Proteins also provide energy, but their main function is to supply nitrogen necessary for the growth and repair of cells. Minerals are required for the growth of bones and teeth. Vitamins prevent certain deficiency diseases and regulate a large variety of body processes. Water serves as a solvent for nutrients and waste materials. It also serves as a regulator of body temperature.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR WORK STATION CLEAN AND IN ORDER. PRACTICE SAFETY AT ALL TIMES.

1. Place about 1.25 ml (1/4 teaspoon) of dextrose sugar (or corn syrup) into a test tube. Add one-half test tube of water and shake the mixture well.

2. Pour in a little Fehling's solution A and B (or Benedict's solution).

Title: LAB--Nutrients

3. Heat the mixture to the boiling point. This is a test for dextrose sugar.

   What color does the mixture turn to?

4. Place a small piece of potato (or other starchy food) into a test tube. Add a drop or two of tincture of iodine (or iodine dissolved in a potassium iodide solution). This is a test for starch.

   What color results?

5. Rub a small amount of butter (or other fatty food) onto a piece of unglazed writing paper.

6. Warm the paper (DO NOT BURN) by holding it 5 to 7 cm above a low bunsen burner flame. Examine the spot on the paper. This is a test for fats or oils.

   What happened to the paper?

7. Place a piece of lean meat (or other protein food) in an evaporating dish. CAREFULLY pour a few drops of concentrated nitric acid over the meat. REMEMBER TO HANDLE ALL ACIDS WITH CAUTION.

   What results?

8. Wash the meat with water. Add a few drops of ammonium hydroxide. This is a test for protein.

   What happens to the food?

9. Place a small piece of bread in a crucible. Set it in the pipe-stem triangle on the ring stand.

10. Heat the bread until no smoke appears and all traces of black carbon have burned away. This is a test for minerals. The material left on the bottom of the crucible is a mixture of minerals present in the bread.

    Describe the residue that remains.

CLEAN UP YOUR WORK STATION. DISCARD ALL WASTES IN THEIR PROPER LOCATION. RETURN ALL MATERIALS AS DESIGNATED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____.

Title: LAB--Cold Cream

Unit: Home Chemistry

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To compound cold cream and observe some of its characteristics.

Materials Required:

Evaporation dish, 250 ml beaker, gas burner, test tube, container to hold final product, apron, eye shield, ring stand, tongs, Spermaceti wax, white beeswax, water, mineral oil, borax and a suitable perfume.

Information:

The preparation of cosmetics entails the emulsifying of waxes and oils. The waxes and oils are melted together on the water bath and a solution of borax in water is added slowly to it while stirring. Perfume may be added to the cold cream compound but make sure the temperature is no more than 40° C (104°F) otherwise the alcohol base perfume will evaporate. Other materials such as Mentholated cold creams can be made with camphor or lemon cold cream with oil of lemon.

Also this base of spemaceti wax, beeswax, and borax act as the beginning point for Sun Tan lotion or Vanishing creams.

Procedure:

FOLLOW THE PROCEDURE STEP-BY-STEP. ALWAYS KEEP THE WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. In your evaporating dish place the following quantities of waxes which have been cut into small pieces:

   2.5 grams of spermaceti wax
   2.4 grams of white beeswax

2. Place the evaporating dish on the top of a beaker of boiling water until the waxes are just melted at 80°C (144°F).

3. Pour 12 grams of mineral oil slowly into the completely melted wax. Stir constantly.

4. Turn out the fire. Remove the beaker and evaporating dish from the ring stand. Use beaker tongs or very thick pad of paper towel to protect your hands.

5. Heat 4 ml of borax solution in a test tube to just 80°C.

6. Add the hot borax solution slowly to the melted wax and oil. Stir the mixture constantly. Constant stirring is necessary to obtain a good emulsion.

7. Remove the evaporating dish from the top of the hot beaker. Continue to stir the cold cream until it has cooled to room temperature. A drop of perfume may be added when the cold cream is at about 40°C.

8. Describe the cold cream:

   a) What color is it?_____

   b) What is its consistency, that is, thick?, soft?, smooth?_____

   c) Does a tiny bit spread smoothly on the skin?

Questions to Answer:

1. How do the emulsifying agents act to keep the waxes and oil mixed with the water? (Think of egg white with oil and water).

_____

_____

_____

2. Why is the perfume not added until the cream is cooled nearly to room temperature?

_____

_____

3. What is the source of spermaceti wax? (Hint: Look up spermaceti in the dictionary)

_____

_____

INSTRUCTOR'S INITIALS_____

CLEAN THE WORK STATION. BE CERTAIN THAT EVERYTHING IS IN ORDER AS DIRECTED BY YOUR INSTRUCTOR.

BUILDING

MATERIALS

Title: LAB--Quicklime and Hydrated Lime

Unit: Building Materials

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with the properties and preparation of quicklime and hydrated lime.

Materials Required:

Ring stand, ring, pipe-stem triangle, iron crucible, high temperature burner (fisher or meker), striker, funnel, filter paper, 2 250-ml. beakers, watch glass, metal scoop, stirring rod, glass tubing (or dropper), eye shield, apron, asbestos mitts or gloves, marble chips (limestone, white blackboard chalk, eggshells, etc. may be substituted), water, red litmus paper, hydrated lime.

Information:

Limestone and marble are important building materials. They are both varieties of calcium carbonate, $CaCO_3$. Commercially, the limestone is heated to produce quicklime (or unslaked lime), CaO, and carbon dioxide, CO_2. A specific amount of water is added to the quicklime to produce hydrated lime (or slaked lime). Both quicklime and hydrated lime can be used to make mortar and plaster.

Limewater is used as a test for carbon dioxide. The clear limewater turns cloudy or milky in the presence of carbon dioxide (limewater is a water solution of calcium hydroxide and, when mixed with carbon dioxide, calcium carbonate - a precipitate - and water result.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. DO YOUR OWN WORK. KEEP WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

PART ONE.....PREPARATION OF LIMEWATER

1. Place about 1/2 teaspoon (2 grams) of hydrated lime in a beaker of water.
2. Stir thoroughly for one minute.
3. Set up filtering apparatus.
4. Carefully filter the lime and water mixture into a second beaker. The filtrate is clear limewater.
5. SAVE THE FILTRATE. Clean up the apparatus.
6. What is the limewater used as a test for?

INSTRUCTOR'S INITIALS_____

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Title: LAB--Quicklime and Hydrated Lime

PART TWO.....PREPARATION OF QUICKLIME

1. Place iron crucible in a pipe-stem triangle and place on ring stand. Set up high temperature burner.
2. Place three or four small pieces of marble chips into the crucible. Light burner, Adjust ring so crucible is in hottest part of the flame.
3. Strongly heat the crucible until it is red hot. Continue to heat for 15 to 20 minutes more.
4. Dip stirring rod into limewater (from Part One) and hold near the top of the crucible. BE CAREFUL OF THE FLAME AND HEAT FROM THE BURNER.

   What happened to the limewater?
   What does this indicate?
5. Turn off burner and ALLOW CRUCIBLE TO COOL.
6. Carefully dump contents of crucible onto a watch glass. Examine the material.

   How does it compare with the marble chips you started with?

   What is this material called?

   SAVE THE MATERIAL JUST PREPARED.
7. Complete the equation to show what occurred in this part of the lab:

   $CaCO_3 \xrightarrow{\Delta}$ _____ + _____

PART THREE.....PREPARATION OF HYDRATED LIME

1. Take material prepared in Part Two of this lab. With a dropper, or glass tubing, place about 10 drops of water on the material. Describe the reaction that takes place.

   What problems in storage might there be if quicklime were used for mortar or plaster?

2. Rub a piece of red litmus paper against the wet portion of the material.

   What happened to the litmus paper?
   What does this indicate?
   What is the material called?

Title: LAB--Quicklime and Hydrated Lime

PAGE THREE

3. Complete the equation to show what occurred in this part of the lab:

$CaO + H_2O \rightarrow$ _____

4. Dispose of material as directed by your instructor. DO NOT DUMP INTO SINK. Wash and dry watch glass.

5. Place a little hydrated lime on watch glass (about a teaspoon or three or four grams). With a dropper, or glass tubing, place about 10 drops of water on the lime.

   Did a reaction take place?

   How does the reaction, or lack of one, compare with that of water and quicklime (Step One)?

6. Rub a piece of red litmus paper against the wet portion of the hydrated lime.

   What happened?

   How does the result compare with that of Step Two?

CLEAN UP YOUR WORK STATION. PLACE EVERYTHING AS INDICATED BY YOUR INSTRUCTOR. INSTRUCTOR'S INITIALS_____.

Title: LAB--Cement/Mortar

Unit: Building Materials

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with mortar and its ingredients.

Materials Required:

Portland cement, fine aggregate (sand), quicklime (calcium oxide), hydrated lime (calcium hydroxide), water, 2 watch glasses or metal covers, mixing tray or dish, carboard mat, form oil, apron, eye shield.

Information:

Portland cement is mainly used in two forms, namely, concrete and mortar. In either case, the cement is mixed with water (to act as a paste) and other materials known as aggregates. When the aggregate is fine, such as sand, it is called cement mortar. When fine and coarse aggregate, such as washed stone or trap rock, is used it is called concrete.

In the past, a lime mortar was used. It was a mixture of hydrated lime, sand, and water. Today, it has been largely replaced by cement mortar. A straight cement mortar is difficult to work with therefore, about 15% hydrated lime is usually added to increase its plasticity. This mixture is used to bond bricks, concrete and cinder blocks, or even as a source of building exteriors.

A standard mixture contains 1 part cement to 2 or 3 parts of fine aggregate (sand) and just enough water to make the mix workable. Of course, the hydrated lime is also added to improve the plasticity. The strength and watertightness of mortars increases with the proportions of cement. To make a mix stronger and more waterproof, a 1:1 ratio of cement and sand is used.

Procedure:

KEEP THE WORK AREA CLEAN. AVOID "DUSTING". DO NOT DUMP ANY MATERIAL INTO THE SINK. WIPE UP ANY DRY SUBSTANCES IMMEDIATELY AND, IF WET, PURGE WITH WATER THOROUGHLY BEFORE CLEANING.

PART ONE.....LIME

1. Place a few lumps of quicklime (also known as unslaked lime) in a metal cover or watch glass (used as a "pan"). Do the same for a sample of hydrated lime (also known as slaked lime).

Title: LAB--Cement/Mortar

2. Carefully allow a FEW DROPS of water to fall on each sample. DO NOT COMPLETELY WET THE SAMPLES.

3. After a few minutes, carefully touch the underside of each "pan".

   What is noticeable?
   Does anything appear to be rising from either sample?

4. In 10 to 15 minutes you will check the samples again. While you are waiting, prepare an "oiled" mat to be used for the next parts of the lab. Apply a thin, thorough coating or oil to ONE SIDE of the cardboard. This coated side should FACE UP.

5. Check the samples again. What is left in each pan?
   How did the two samples compare?
   What generalizations can you make?

6. Clean work area. INSTRUCTOR'S INITIALS_____.

PART TWO.....LIME MORTAR

1. Check triple beam balance. Weigh out 30 grams of hydrated lime and 30 grams of fine aggregate (sand). Don't forget to consider the weight of the container into which you are placing the samples when weighing out the quantities.

2. Mix the sand and lime together. Then add enough water (DO NOT USE TOO MUCH) to make the mix plastic.

3. On the oiled mat, shape TWO flat disks about 6 millimeters (1/4") thick. Allow to stand UNDISTURBED for one hour.

4. After about an hour, test one disk for plasticity. What has occurred?

   Try to scratch the second disk. Has it set or has it become permanently hardened?

5. Clean work area. INSTRUCTOR'S INITIALS_____

PART THREE.....CEMENT MORTAR

1. Mix about 75 grams of portland cement with 150 grams of sand. ADD ONLY ENOUGH WATER TO MAKE THE MIX WORKABLE.

2. Divide the mix into THREE portions to be used as follows:

Title: LAB--Cement/Mortar

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PORTION A.....

3. Using ONE portion, shape 2 disks on the oiled mat.

4. After several hours, test ONE disk for plasticity and scratch to test for hardness. What are the observations?

5. After 4 to 7 days, test the SECOND disk as described above (Part 3, Step 4). What are the observations?

   What comparisons can you make?

PORTION B.....

6. Using the SECOND portion, add 4 grams of hydrated lime to the mix. How does the resulting mixture compare in plasticity to the rest of the mix?

   Does it trowel better?

PORTION C.....

7. Use the REMAINING portion to make three disks on the oiled mat. The disks should be about 12 millimeters (1/2") high. LABEL EACH DISK FOR IDENTIFICATION.

8. Allow all disks to stand overnight. Examine disk #1. Has it set?

   Test for hardness by scratching and for strength by breaking.

   What are your observations?

9. Cover disk #2 with a damp cloth for several days. Repeat the test on this disk as described above (Part 3, Step 8). What are your observations?

10. Keep disk #3 in water for several weeks, checking for hardness every couple of days. When does it reach maximum hardness?

11. Record all information and data and make the necessary conclusions.

CLEAN UP YOUR WORK STATION. BE CERTAIN THAT ALL EQUIPMENT IS PLACED AS DIRECTED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____

Title: LAB--Concrete Mixtures

Unit: Building Materials

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To make calculations for various concrete mixtures, to prepare various concrete mixtures, and to determine their resulting compressive strengths.

Materials Required:

Portland cement, fine aggregate, coarse aggregate, hydrated lime, tap water, salt water, sugar water, tubular forms, form oil, mat or plate, tamping rod, mixing tray or dish, triple beam balance, rags or burlap, meter stick or ruler, apron, eye shield, compression jack with gage or universal testing machine with compression apparatus.

Information:

Concrete is a mixture in which the paste of PORTLAND CEMENT and WATER binds AGGREGATES (inert materials such as sand and gravel, crushed stone) into a rocklike mass as the paste hardens through the chemical action of the cement and water. The proportions for a good concrete mix are generally determined by job specifications or design standards. They are dependent upon the use to which the concrete is to serve, as well as the strength that is required.

Along with proper proportions, it is also important to use the proper materials. The size of aggregate, for example, affects the strength and workability. The purity of water also has a definite affect on the strength and durability of the mix. These requirements are also normally governed by standard practice, design standards, and specifications.

The relation of water to cement is usually referred to as the water-cement ratio (w/c ratio). The higher the ratio of water used per unit of cement, the less durable and strong will be the resulting concrete. Too much water makes the paste thin and diluted, and it's too weak to bind the aggregates firmly. Good concrete may be produced by lowering the water-cement ratio as much as possible without decreasing the workability of the mix.

Generally, if properly prepared and cured, the strength of concrete will increase with age. For testing purposes, samples are examined at seven, fourteen, and twenty eight days. Obviously, its maximum test strength should be achieved by the 28th day. The actual strength of the concrete mixes will again depend on a number of factors. Included in these factors are the method of

curing, quality of materials, ratio of water to cement, type of cement used in the mix, method of pouring, and others. For example, a mix after 14 days can achieve a strength range of from 2500 to 5500 psi (compressive strength). What is actually acceptable is dependent on the requirements for use.

Concrete has ahigh compressive strength and a low tensile or flexural strength. In other words, if squeezed it has a high strength in comparison to if it is bent or pulled apart. This deficiency in tensile strength is overcome by using steel bars imbedded in the wet mix or the mix is poured over and around them (this is called REINFORCED CONCRETE). Another method is to use rods or cables which are stretched in the forms and the concrete is poured around them. After proper setting time, the tensile force is removed (this is known as PRE-STRESSED CONCRETE).

The tests which are standardized for many materials (including concrete) are established by the American Society for Testing Materials (ASTM). This standardization of testing provides for easy and uniform comparison of test data. This lab will include a variation of a standard ASTM test for the compressive strength of concrete.

Procedure:

PART ONE.....COMPUTATIONS

(THIS PORTION OF THE LAB IS TO BE PREPARED PRIOR TO THE ACTUAL LAB WORK)

1. Measure the tubular form. The diameter is _____ inches. Divide the diameter by two--this is the radius. The radius is _____ inches. The height or length is _____inches.

2. Determine the volume of the form. It is a cylinder. It is common practice to determine the cross-sectional area (a circle) and multiply this by the height or length. The cross-sectional area (22/7 or 3.14 times the radius squared) is _____square inches. The volume (area of the cross-section times the height or length) is _____cubic inches. If 2.54 centimeters are in one inch, the number of cubic centimeters in one cubic inch is_____. The volume in cubic inches times this value indicates that the volume is also equal to _____ cubic centimeters.

3. Use the mix indicated below, as assigned by your instructor. CIRCLE THE MIX THAT WAS ASSIGNED TO YOUR GROUP.

I.	1:2:3	workable
II.	1:2:3	workable plus 1/4 more water
III.	1:2:3	workable with salt water
IV.	1:2:3	workable with sugar water
V.	2:3:1	workable
VI.	3:2:1	workable
VII.	2:1:3	workable
VIII.	3:1;2	workable
IX.	1:2:0	workable
X.	1:2:0	workable with 10 grams lime added
XI.	1:0:0	workable
XII.	1:0:2	workable

Assume that the total volume (in cubic centimeters) is numerically equivalent to the total mass of solids (in grams) times 2.3. The total mass of solids for the mix is _____ grams. Compute the proportions of each ingredient for the mix assigned to your group. The mass of cement is _____grams; the mass of fine aggregate is _____ grams; and the mass of coarse aggregate is _____ grams. INSTRUCTOR'S INITIALS_____.

PART TWO.....MIX AND CYLINDER PREPARATION

KEEP THE WORK AREA CLEAN. AVOID "DUSTING". DO NOT POUR ANY MIX INTO THE SINK. WIPE UP ANY DRY SUBSTANCES IMMEDIATELY AND, IF WET, PURGE THOROUGHLY WITH WATER BEFORE CLEANING.

1. Weigh out each solid ingredient indicated in Step 3, Part 1. Place in mixing container and mix thoroughly. Lime should be added at this time if called for.

2. Assume, to begin with, that the water-cement ratio is 0.3 milliliters per gram (0.3 milliliters of water for each gram of cement). The total mount of water that should be required for the assigned mix is _____ milliliters. Start with this amount, but ONLY ADD ENOUGH TO MAKE A WORKABLE MIX (more may be added if necessary). The amount of water actually needed is _____ milliliters. If your mix calls for extra water, add it at this time. The added water is _____ milliliters. INSTRUCTOR'S INITIALS_____.

3. Place the tubular form on an oiled mat or plate. Carefully pour the mix, ONE THIRD AT A TIME, into the form. Rod each layer 16 times as EACH THIRD IS POURED, with the rod extending PARTIALLY into the previously poured third.

4. After the pouring and rodding is completed, carefully trowel the top of the cylinder to get a relatively smooth surface. Cover the mix in the cylinder with a piece of wet rag or burlap. Check DAILY to see if it is wet.

CLEAN UP YOUR WORK STATION. BE CERTAIN THAT ALL EQUIPMENT IS PLACED AS DIRECTED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____

PART THREE.....PHYSICAL TESTING

(THIS PORTION OF THE LAB WILL BE PERFORMED BY EACH GROUP WITH OTHER GROUPS OBSERVING AND COLLECTING DATA. TESTING AREA WILL BE CLEANED AFTER EACH SAMPLE IS TESTED)

1. After 7 or 14 days (or as designated by your instructor), CAREFULLY strip the forms from the mix.

2. Place the concrete speciman in the compression jack or universal testing machine. BE CERTAIN THAT SAFETY GLASSES AND A SHIELD ARE USED.

3. Apply a compressive load to the speciman, observing the reaction of the speciman. Sketch the type of failure that occurred (shear or "cone"; splitting or "columnar"; or combination shear and splitting failure). RECORD THE ULTIMATE LOAD IN THE CHART. CLEAN TEST AREA.

4. Stress is determined by taking the force applied (ultimate load) and dividing it by the cross-sectional area (from Step 2, Part 1). COMPUTE THE COMPRESSIVE STRESS FOR EACH SPECIMAN AND RECORD IN CHART.

5. For this lab, a stress adjustment will be made to get a more realistic value. The strength correction factor relates to cylinder height and diameter. An average value will be used for this lab. Multiply the compressive stress by 1.06. RECORD THE CORRECTED STRESS IN THE CHART.

6. Write a formal conclusion for this lab. Include graphs and sketches as necessary.

Title: LAB--Concrete Mixtures

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SPECIMAN NUMBER	TOTAL LOAD (pounds)	CROSS-SECTIONAL AREA (sq. in.)	COMPRESS-IVE STRESS (psi)	CORRECTED STRESS (psi)
I				
II				
III				
IV				
V				
VI				
VII				
VIII				
IX				
X				
XI				
XII				

Title: LAB--Concrete Mixtures

INSTRUCTOR'S NOTES

Have the students bring in the tubular forms. They are the cardboard inserts from a roll of toilet paper. Their dimensions are reasonably standard. Cardboard inserts from paper towels or wrapping paper can also be used, but they should be cut to about a 4½ inch length. The diameters of the inserts should be around 1⅛ inches.

Before the lab, the tubular forms should be coated with paraffin or reinforced with three wraps of scotch or masking tape (at each end and in the middle).

COMMENTS:

Title: LAB--Colorimetric Test

Unit: Building Materials

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORK DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with the Colorimetric Test for organic impurities in fine aggregate.

Materials Required:

Fine aggregate (sand), 3% sodium hydroxide solution, 12 oz. graduated clear glass bottle with stopper (prescription bottle), apron, eye shield.

Information:

The quality of concrete or mortar will be no better than the materials used to make it. Proper selection of aggregate is one important factor that affects the strength and durability of the resulting mix.

The Colorimetric Test is a method for approximate determination of the presence of injurious organic compounds in natural sands which are to be used in cement mortar and concrete. The principle value of the test is to furnish a warning that further tests of the sands are necessary before they are approved for use.

Organic material, often in the form of humus or organic loam, is one of the principle offenders in causing adverse chemical reactions in concrete or mortar. This contamination is usually only found in fine aggregate. In some cases, it can keep the mix from hardening.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. KEEP THE WORK STATION CLEAN AT ALL TIMES. DO YOUR OWN WORK. PRACTICE SAFETY AT ALL TIMES.

1. Fill the graduated clear glass bottle to the 4½ ounce mark with the sand sample to be tested.
2. CAREFULLY add the 3% solution of sodium hydroxide. BE CAREFUL OF THE EYES AND SKIN WHEN USING THIS SOLUTION. IF SPLASHED ACCIDENTALLY, FLUSH THOROUGHLY WITH WATER. Fill to the 7 ounce mark.
3. Place cover or stopper on bottle and shake thoroughly.
4. Allow bottle to stand 24 hours.

5. Compare the sample you prepared to the reference standard color solution prepared by your instructor. If it is the same or lighter than the standard it is acceptable (little or no organic matter). If it is darker than the standard it is unacceptable (too much organic matter) and if it is to be used, it will require further testing.

OR, IF A STANDARD COLOR SOLUTION HAS NOT BEEN PREPARED

If it is colorless, it contains no organic matter, If it is straw colored, it contains little organic matter but not enough to be serious. If it is light brown or darker, it does contain injurious organic matter and should be rejected.

CLEAN UP YOUR WORK STATION. BE CERTAIN THAT ALL MATERIAL IS PLACED AS DIRECTED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____

Title: LAB--Colorimetric Test

INSTRUCTOR'S NOTES

A reference standard color solution may be prepared if desired. It should be prepared at the same time as the test sample.

REFERENCE STANDARD COLOR SOLUTION.....

Add 2.5 ml. of 2% solution of tannic acid in 10% alcohol to 97.5 ml. of 3% sodium hydroxide solution.

Place in 12-ounce bottle, stopper and shake vigorously. Allow to stand 24 hours.

COMMENTS:

Title: LAB--Moisture Content

Unit: Building Materials

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To determine the amount of water contained in an aggregate used for making concrete or in sand used in making a mold for casting metals.

Materials Required:

Triple beam balance, aggregate sample, evaporating dish or similar container, asbestos mitts or gloves, marker sticks, drying oven (or bunsen burner apparatus), apron, eye shield.

Information:

In order to determine the total amount of water to be added to a dry concrete mix, the water that is already in the aggregate must be considered. The total water required for the mix must then include the water in the aggregate.

The amount of water contained in sand to be used for casting is also a critical consideration. If there is too much, as well as too little, moisture in the sand, the mold will not hold its shape properly.

The equation for determining the water or moisture content, normally expressed as a per cent is

$$w(\%) = \frac{W_w - W_d}{W_d - W_c} \times 100$$

where, $w(\%)$ = moisture content as a per cent
W_c = weight of the container
W_w = weight of wet sample of aggregate and container
W_d = weight of dry sample of aggregate and container

This equation reduces itself to

$$w(\%) = \frac{\text{Amount of moisture in the aggregate}}{\text{Amount of dry aggregate}} \times 100$$

Title: LAB--Moisture Content

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. KEEP YOUR WORK STATION CLEAN AND IN ORDER. DO YOUR OWN WORK. PRACTICE SAFETY AT ALL TIMES.

1. Zero in triple beam balance. Weigh container. Weight (W_c) = _____ grams.

2. Place sample of aggregate in container (container DOES NOT have to be full). Weigh aggregate and container. Weight (W_w) = _____grams.

3. Place aggregate and container in drying oven to remove the moisture. Be certain that the marker stick has been placed with the sample so that it can be identified. The time needed to dry out the sample is around 20 minutes or more.

   OR, IF AN OVEN IS NOT AVAILABLE

   Set up a bunsen burner apparatus and heat the sample. Stir so that the sample is not burned. Heat until all moisture is driven off.

4. After all moisture has been removed, take the dry sample and container from the oven (USE THE ASBESTOS MITTS SINCE THE CONTAINER AND SAMPLE MAY BE VERY HOT). Weigh container and sample. Weight (W_w) = _____ grams.

5. Calculate the moisture content using the equation mentioned in the information for this lab. Use the space below for substitution and calculations:

The moisture content, w(%) = _____%.

CLEAN UP YOUR WORK STATION. BE CERTAIN THAT ALL MATERIALS ARE PLACED AS DIRECTED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____.

Title: LAB--Moisture Content

INSTRUCTOR'S NOTES

If possible, sample for moisture content should not be less than 100 grams.

If stove or burner is used to drive out moisture, sample should be stirred to prevent burning.

If sample being tested is already dry, it is advisable to add water so a moisture content can be determined by the student. Mix sample as water is added.

COMMENTS:

Title: LAB--Preservative Application

Unit: Building Materials

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with the methods of applying creosote preservatives.

Materials Required:

Triple beam balance, tongs, eye shield, apron, ruler or meter stick, creosote, knife or other splitting device, 4 softwood (sapwood) samples, 2 hotplates, 2 thermometers, 3 metal or heavy glass containers, paper towels and rags.

Information:

To prolong the life of wood, chemicals called PRESERVATIVES are used. They, in effect, poison the wood to prevent insect and fungi attack. How much protection the preservative renders depends upon the amount absorbed by the wood and the depth and uniformity of penetration.

Preservatives are generally applied by one of two methods, namely, SURFACE TREATMENT AND IMPREGNATION. In surface treatment, as it implies, the surface of the wood is treated with the preservative by brushing, spraying, dipping, soaking, etc. Penetration, obviously is not too deep. Impregnation affords better protection by forcing the preservative into the wood. It is forced in by using hot and cold baths or pressure (the pressure method provides the most effective protection). In the hot and cold bath treatment, which will be considered in this lab, the wood is soaked in a hot preservative first. This causes the air in the cell cavities to expand and permits some to escape. When placed into the cold bath, the air that remains contracts and creates a partial vacuum (due to a decrease of pressure). Atmospheric pressure which is now greater than the pressure in the cell cavities then forces the preservative into the cells.

CREOSOTE is an oily liquid which comes from coal or wood tar. It is an excellent perservative. However, it has some limitations. Creosote has a very strong odor. When first applied, it increases the wood's flammability. It can be irritating to the skin. It cannot be painted over.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. DO YOUR OWN WORK. KEEP WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

Title: LAB--Preservative Application

REMEMBER--CREOSOTE IS FLAMMABLE, IRRITATING TO THE SKIN, AND CAUSES STAINING. BE CAREFUL NOT TO SPLASH THE CREOSOTE OR DRIP IT.

PART ONE.....PREPARATION

1. Select 4 wood samples and mark each one (A to D) for identification.
2. Check triple beam balance for zero. Weigh each of the samples and record their "weight before treatment" on the DATA SHEET.
3. Your instructor will prepare the treating areas for the next portions of the lab. Take note of their locations.

INSTRUCTOR'S INITIALS_____.

PART TWO.....SURFACE TREATMENT

1. Take samples A and B and place one end of each into the container of room temperature creosote. Use tongs and avoid splashing. Allow to soak.
2. After 10 minutes, carefully remove Sample A. DO NOT DRIP CREOSOTE (hold paper towel or rag under the sample when transporting). COVER PAN OF TRIPLE BEAM BALANCE TO AVOID STAINING. Weigh sample and record "Weight after treatment" on the DATA SHEET.
3. Carefully split sample A lengthwise, starting from the untreated end. Note the penetration. Record observations on DATA SHEET.
4. After one hour, repeat the procedure for sample B.
5. How did the two samples compare?
   Was there any difference in penetration?

INSTRUCTOR'S INITIALS_____

PART THREE.....HOT AND COLD BATH TREATMENT

1. Take samples C and D and carefully place them into the hot (210-220°F) creosote bath. REMEMBER TO USE CAUTION SINCE CREOSOTE IS FLAMMABLE. AVOID SPLASHING. Allow to soak.
2. After about 1½ hours, carefully remove sample C. AVOID DRIPPING CREOSOTE. COVER PAN ON BEAM BALANCE. Weigh sample and record "weight after treatment" on DATA SHEET.

Title: LAB--Preservative Application

PAGE THREE

3. Split sample carefully as before and note penetration of preservative. Record observations on DATA SHEET.

4. Place sample D into cold (100° F) creosote bath and allow to soak.

5. After 1½ hours carefully remove the sample. Weigh and split sample and record information on DATA SHEET.

6. How did these two samples compare?
   Was there any penetration difference?
   How did they compare to the previous two samples?

CAREFULLY CLEAN UP YOUR WORK STATION. DISCARD ALL CREOSOTE SOAKED WOOD, RAGS, ETC. IN THE AREA DESIGNATED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____

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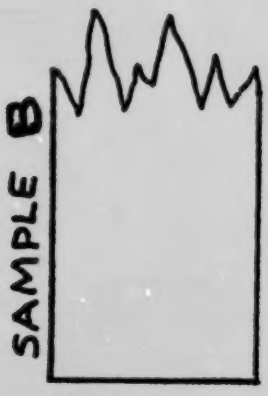
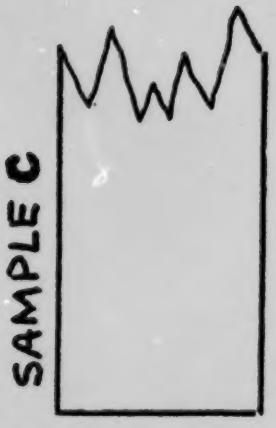
Title: LAB--Preservative Application - DATA SHEET

PAGE FOUR

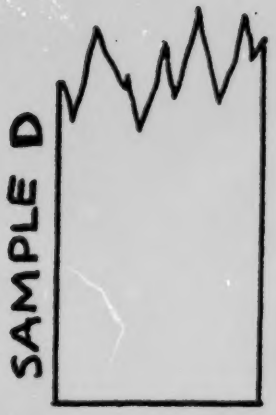
WEIGHT BEFORE _____
WEIGHT AFTER _____
COMMENTS:



WEIGHT BEFORE _____
WEIGHT AFTER _____
COMMENTS:



WEIGHT BEFORE _____
WEIGHT AFTER _____
COMMENTS:



WEIGHT BEFORE _____
WEIGHT AFTER _____
COMMENTS:

Title: LAB--Preservative Application

INSTRUCTOR'S NOTES

In the interest of safety, the instructor may wish to run this lab as a demonstration.

COMMENTS:

Title: LAB--Wood and Its Treatment

Unit: Building Materials

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To study the physical qualities and compressive strengths of various wood samples and to determine their fire resistant qualities when treated.

Materials Required:

4 samples each of a hardwood, a softwood, and a plywood (2 samples of each shall be left untreated, 1 shall be treated with creosote, and 1 shall be treated with a zinc chloride solution), triple beam balance, meter stick or other measuring device, bunsen burner, tongs, watch or other timing device, compression jack or universal testing machine, apron, eye shield.

Information:

Many woods can be identified by their physical appearance or characteristics. Among these are color, texture, grain structure, density, etc.

Density is the weight per unit of volume. It is normally expressed in pounds per cubic foot. A formula for computing density is

$$\text{DENSITY} = \frac{\text{WEIGHT in pounds}}{\text{VOLUME in cubic inches}} \times 1728 \text{ cu. in./cu.ft.}$$

The density in the above formula would result in the proper units (i.e., pounds per cubic foot). It should be remembered that if a beam balance is used, the weight is usually measured in grams and this must be converted to pounds (454 grams = 1 pound).

Some typical densities of woods are: Douglas Fir, 34 pcf; White Pine, 26 pcf; Oak, 45 pcf; Maple, 44 pcf; Cherry, 35 pcf.

Woods are often treated with preservatives. Some of the preservatives prevent decay, insect attack, and burning. Some are used to prevent only one of the items just mentioned. The type of preservative used depends on the actual use of the wood.

With reference to burning or combustion, two terms are often used--fireproof and fire resistant. Fireproof normally is used to indicate that the material cannot be burned or will not take part in combustion. Fire resistant indicates that the material could possibly be burned or take part in combustion, BUT only AFTER a certain period of time has elapsed. It will glow and smolder rather than burst into flames.

Title: LAB--Wood and Its Treatment

PAGE TWO

For your information, the following formula (recipe) for FIRE-PROOFING FOR WOOD is presented:

120 grams (1/2 cup) Zinc Chloride; 60 grams (1/4 cup) Ferric Chloride or Iron II Chloride; 45 grams (3 tablespoons) Boric Acid; 45 grams (3 tablespoons) Ammonium Phosphate; and 1920 milliliters (2 quarts) water.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. DO YOUR OWN WORK. KEEP WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Take one sample of each UNTREATED wood. Measure the length, width and thickness. Record data on chart.

2. Weight each sample in Step 1 and record the data on the chart.

3. Take second sample of each UNTREATED wood and place in the compression jack or universal teating machine. Apply the load to the speciman until it fails. Record the ultimate load in the chart.

4. Take one TREATED sample, with tongs, and place into flame of bunsen burner, determining the length of time it takes for the sample to BURN FREELY. Record the data in the chart. Repeat for the other TREATED sample and the UNTREATED sample.

5. BE CERTAIN THAT ALL THE APPROPRIATE DATA IS RECORDED IN THE CHART.

6. Compute the volumes (length x width x thickness), the weights (i.e., convert the grams to pounds), the densities (refer to the formula in the Information), and the ultimate compressive stresses (total load divided by cross-sectional area -- remember that area is the width x the thickness).

7. Write a FORMAL LAB REPORT, following the proper lab report format. Use a BAR GRAPH to show the burning time data. Use any charts or graphs that may be necessary to display the other information.

CLEAN WORK STATION. PLACE EQUIPMENT WHERE DIRECTED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____.

DATA CHART

			HARDWOOD	SOFTWOOD	PLYWOOD
COLOR, GRAIN AND OTHER PHYSICAL FEATURES					
OBSERVED DATA		WEIGHT grams			
		LENGTH inches			
		WIDTH inches			
		THICKNESS inches			
		LOAD pounds			
	BURNING TIME sec.	UNTREATED			
		CREOSOTE			
		ZINC CHLORIDE			
COMPUTED DATA		WEIGHT, pounds			
		AREA sq. inches			
		VOLUME cu. inches			
		DENSITY pcf			
		STRESS psi			

FUELS

Title: LAB--Forms and Properties of Carbon

Unit: Fuels

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe some of the forms in which the element carbon may be found and some of its properties.

Materials Required:

Iron crucible, laboratory burner, iron ring, ring stand, sand, graphite, boneblack, wood chips, (toothpicks or splints), Q-tips, absorbent cotton, kerosene, clear lacquer, limewater, evaporating dish.

Information:

Every living thing contains the element carbon. In the early days of chemistry, the study of living things was referred to as organic chemistry. Today organic chemistry is a special branch of chemistry which studies all those compounds, living or not, which contain the element carbon. There are more compounds which contain carbon than all other compounds combined. The study of carbon thus becomes very important to the understanding of those things around you.

There are many forms of carbon. Diamonds are pure carbon, but so is graphite, the material from which the lead in your pencil is made. The two are obviously different and you will learn why. A special treatment of wood produces an almost pure form of carbon called charcoal. Yes, the same stuff you cook with in the summer. The same special treatment of soft coal produces another almost pure form of carbon, called coke, which is essential to the production of high quality iron and steel. Carbon touches our lives in many ways.

Procedure:

PART ONE.....PREPARING A SAMPLE OF CARBON (CHARCOAL)

1. Set up a ring stand, iron ring, iron crucible and laboratory burner in preparation for heating. Place a thin layer of sand in the bottom of the crucible. On top of the sand place a layer of wood chips and cover the wood fully with sand. Note: The wood must be well covered.

2. Heat the crucible gently at first then strongly (a very hot flame) until all smoking ceases. Allow the crucible to cool. Remove the wood chips and write down how they appear.

Title: LAB--Forms and Properties of Carbon

PAGE TWO

3. Did the wood "burn"? List the three requirements for a material to burn (combustion) and tell which one, if any, is missing.

PART TWO.....WHAT ARE SOME OF THE USEFUL PROPERTIES OF SOME FORMS OF CARBON?

1. Rub a piece of graphite between your fingers and describe how it feels.

2. Rub the graphite on this page and describe in the data sheet the result.

Graphite Test

3. Soak a wad of cotton in kerosene and place in an iron crucible. Light the cotton swab and describe the appearance of the flame in your data sheet. Do you think this is efficient burning? Why?

4. Hold a cold white evaporating dish in the kerosene flame for 15 to 20 seconds. Describe the result. What is the name of the black stuff on the evaporating dish? Moisten a Q-tip with clear lacquer, rub the Q-tip in the residue on the bottom of the evaporating dish, then mark this page in the space above. What use of the material does this possibly demonstrate?

Cotton Swab Test

5. Strongly heat three grams of boneblack (animal charcoal) for about five minutes. The result is called activated charcoal. After cooling, place the charcoal into a test tube. Pour 10 ml. of brown vinegar into the test tube, stopper, and shake well. Remove the stopper. Note: Observe the proper method for heating liquids in a test tube. Heat the mixture to boiling, filter, and examine the filtrate. Describe the results. Taste the filtrate. Describe the results.

Clean up. Thoroughly wash all laboratory equipment and glassware. with a strong soap and water solution. Glassware must be thoroughly rinsed. Report any broken equipment and glassware to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the kind of condition that you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Title LAB--The Forms and Properties of Carbon

PAGE THREE

Trade Relatedness:

1. List at least three industrial uses for graphite.
2. What is a refractory material?
3. Of what material is the electrode of an electric steel-making furnace made?
4. Kerosene and #2 home heating fuel oil are similar in appearance. What is the difference in burning the kerosene in the laboratory and #2 fuel in the furnace at home? How is efficiency achieved in the home heating plant?
5. List at least five products that use or are made from lampblack.

Conclusions:

1. Name three forms of amorphous carbon. List several uses for each form you can name.
2. Draw illustrations to show the difference between an evaporating dish and a watch glass.
3. Make a list of the physical properties of diamond.
4. Make a list of the physical properties of graphite.

Title: LAB--Analysis of the Heating Value of a Sample of Coal

Unit: Fuels

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To analyze coal for its heating value.

Materials Required:

Centigram balance, iron crucible, ring stand, iron ring, laboratory burner, mortar and pestle, pipestem triangle, samples of coal.

Information:

Coal is formed from the decay of land-type plants and vegetation in the absence of oxygen. The oxygen was kept away from the plants by a layer of water, thus the water became part of the coal. Thus, depending upon the quality, coal may contain a lot of water and other material which cannot be burned and represents a loss of money to the customer.

Coal is often washed at the mine to remove coal dust. It is often sprinkled with water at the dealers to reduce contamination of the air at the buyers house or business. These things can also add water to the coal. The heating value of coal, and other fuels, is rated in BTU's (British Thermal Units) or calories. (Note: "calorie" is spelled with a small case "c" and is not the same as Calorie).

Prerequisite knowledge -- How to use a mortar and pestle; How to use a centigram balance.

Procedure:

PART ONE.....TO DETERMINE THE WATER (MOISTURE) CONTENT OF A COAL SAMPLE

1. Obtain about 25 grams of a sample of coal and grind it into a coarse powder. Weigh out 5.0 grams of the sample.

2. Set up a ring stand, iron ring, and laboratory burner in preparation for heating. (Note: a pipestem triangle may be required to hold the crucible depending upon the relative sizes of the iron ring and crucible). Place the iron crucible on the iron ring. Heat gently at first, then strongly for about four to five minutes to thoroughly dry the crucible. Immediately weigh the crucible to the nearest 0.01 gram. Record the mass in the data sheet.

Title: LAB--An Analysis of the Heating Value of a Sample of Coal

PAGE TWO

3. Place the 5.0 gram sample of coal in the iron crucible, cover, and heat gently for about 30 minutes. Note: the temperature should not exceed 52°C (125°F). Remove the crucible and weigh the crucible and the coal sample combined to the nearest 0.01 gram. Record the value in the data sheet.

PART TWO.....TO DETERMINE THE ASH CONTENT OF A COAL SAMPLE

1. From Step 1a, obtain about 10 to 15 grams of the sample. Measure the mass of your sample to the nearest 0.01 gram. Record the value in the data sheet.

2. Repeat Step 1b above and record the value.

3. Place the coal sample in the crucible and heat with the hottest possible flame (strongly) until nothing but ash remains. Weigh the crucible and remains to the nearest 0.01 gram and record your value in the data sheet.

DATA SHEET

1. Determine the water content of coal

   Weight of the coal sample _____

   Weight of the dry crucible _____

   Weight of the coal sample and the dry crucible combined _____

   Weight of the coal sample and crucible after heating _____

   What is the percentage of water in the coal sample _____

2. Determine the ash content of a sample of coal.

   Weight of a coal sample _____

   Weight of a dry crucible _____

   Weight of the coal sample and the dry crucible combined _____

   Weight of the coal sample and crucible after heating _____

   What is the percentage of ash content in the coal sample _____

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Title: LAB--An Analysis of the Heating Value of a Sample of Coal

Clean up. Thoroughly wash all laboratory equipment and glassware in a strong soap and water solution. Glassware must be thoroughly rinsed. Report any broken equipment or glassware to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the same condition you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Trade Relatedness

1. There are thousands of products whose base material is coal. Research your trade area and list all those products made from coal or a by-product of coal.

2. Name four products obtained directly from the destructive distillation of soft coal.

3. Coal tar (the liquid residue from the destructive distillation) contains over 200 different compounds. These compounds can be separated into useful products by fractional distillation. List the names of several of the more important substances thus obtained.

4. What is the property of charcoal which makes it useful as a deodorizer in air systems such as on submarines.

5. What is the property of charcoal which makes it effective as a decolorizing agent in the manufacture of white vinegar and white karo syrup.

Conclusions:*

1. Why will the ash and water content of samples of coal, even when taken from the same seam, vary in quality?

2. Completely define the terms:
   a. British Thermal Unit
   b. calorie (Note: this is spelled with a small case "c", not a capital)

3. Why is it that anthracite (hard) coal produces less ash and soot than bituminous (soft) coal?

4. Name the five different stages of coal formation and describe their respective appearances and characteristics.

5. Explain why a cheap grade of coal may be more expensive to use than a higher priced grade.

* Reference: "Coal", The World Book Encyclopedia.

12/29

Title: LAB--Destructive Distillation of Wood

Unit: Fuels

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe the destructive distillation process and to study the products and by-products of the process.

Materials Required:

Ring stand, burrett clamp, ignition tube (large hard glass test tube), flask, erlenmeyer, 125 ml. fitted with a #5 two-hole stopper, beaker, 400 ml; laboratory burner, flame spreader, jet tip, test tubes, test tube rack, toothpicks (sawdust or wood shavings), litmus papers, miscellaneous glass and rubber tubing, lead acetate test paper, distilled water, hydrochloric acid, concentrated; carbon tetrachloride, CCl_4; sodium hydroxide, NaOH; copper (II) oxide.

Information:

The process of destructive distillation is to raise the temperature of a material, wood or coal in this laboratory, to a point that it should burn. However, the material is heated in a closed container so that oxygen cannot get to the material. The result is that many gases, moisture and other materials are driven out of the wood (or coal) to produce charcoal (or coke). The byproducts from the process contain many valuable substances which are collected (as you will do in the lab) and used to make many useful products. Some of these products are methyl alcohol, acetic acid, and acetylene.

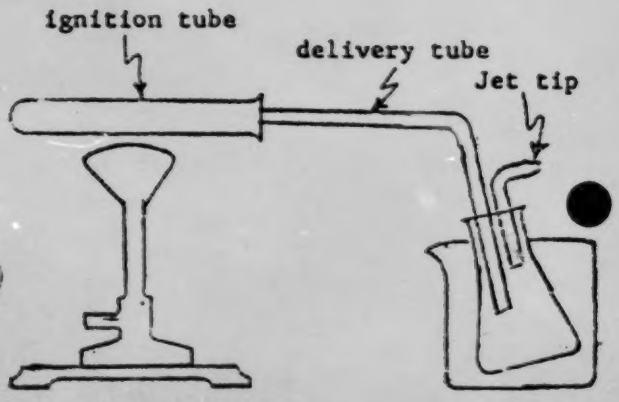
Procedure:

PART ONE.....TESTING THE GASES THAT ARE NOT CONDENSED AT ROOM TEMPERATURE.

1. Fill the ignition tube full of toothpicks and clamp to the ring stand as shown. Assemble the delivery tube and jet tip to the condenser.

   CAUTION: Blow through the assembled delivery tube, condenser, and jet tip to be certain air passes freely. Complete the assembly of the entire apparatus as shown at the right.

Apparatus for the destructive distillation of wood or coal



2. Gently heat the ignition tube first, then heat strongly with a burner fitted with a flame spreader. As gases begin escaping from the jet tip, quickly complete the following tests:

   A. Test the gases with litmus paper moistened with distilled water.

   B. Test the gases with lead acetate paper moistened with distilled water (this is a test for the presence of hydrogen sulfide).

   C. Bring a lighted splint to the end of the jet tip (this test may have to be repeated).

   Describe the results of these tests in your data sheet. When nothing else appears to be happening, you may stop heating the ignition tube.

PART TWO.....TESTING THE LIQUID IN THE CONDENSER

1. Disassemble the apparatus but save all the materials. Describe the appearance of the liquid in the condenser: color, odor (smell) viscosity.

2. Can you find two separate layers of liquid?

3. Test the material with litmus. Is this acidic or basic?

PART THREE.....TESTING THE SOLID RESIDUE IN THE IGNITION TUBE.

1. Remove the solid residue from the ignition tube. Carefully examine it and describe its appearance in your data sheet: color, odor (smell), brittleness, density.

2. In each of four separate test tubes, pour 2 ml. of distilled water, 2 ml. of hydrochloric acid, 2 ml. of sodium hydroxide, and 2 ml. of carbon tetrachloride. Place one or two pieces of the residue from the ignition tube into each test tube. Stopper the test tubes, shake well, and examine the test tubes for any reaction. Describe the results.

3. Test a piece of residue to see if it will burn. Record the result.

4. Grind several pieces of the residue in a mortar and add an equal amount of copper (ii) oxide (cupric oxide). Mix the two powders well. Place the mixture in a clean ignition tube and clamp the tube in a nearly horizontal position. Heat the mixture gently at first, then strongly for several minutes. Allow the tube to cool and examine the contents. Record your observations.

Clean up. Thoroughly wash all laboratory equipment and glassware in a strong soap and water solution. Glassware must be thoroughly

Title: LAB--Destructive Distillation of Wood

rinsed. Remember: A place for everything - everything in its place. Leave the laboratory area in the same condition you would like to find it. Have consideration for your fellow classmates who must also use the laboratory.

Trade Relatedness:

1. List three uses for charcoal.
2. List two important uses for coke.
3. The destructive distillation of animal bone makes what material? How is this material used commercially in the production of white karo syrup and white vinegar?
4. Coal gas, a by-product of the coking process, must be purified by removing what two compounds?
5. A very poisonous compound found in coal gas is _____.
6. What is "activated charcoal" and what are its commercial uses?

Conclusions:

1. In the destructive distillation of wood, what is the name of the tar-like material in the condenser. List some commercial products made from it.
2. Name five categories of material which are obtained from the destructive distillation of soft coal.
3. Destructive distillation is a (physical, chemical) change, because, the original substances are _____ _____.
4. The compounds in wood tar, or coal tar, may be separated by the process of _____, which is a (chemical, physical) process.
5. Pyroligneous acid is a mixture of what three major substances?

Title: LAB--Oxides of Carbon

Unit: Fuels

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To study the formation of and to test for carbon dioxide, and to study other compounds of carbon.

Materials Required:

Carbon dioxide generator or bottled carbon dioxide, gas collecting bottles, glass plates, test tubes, water (pneumatic) trough, laboratory burner, delivery tube, marble chips, hydrocholoric acid, concentrated, 3 ml.; limewater, wood splints, candle, litmus paper, distilled water.

Information:

There are two major compounds of carbon and oxygen, both of which, in sufficient quantity can kill you. These two major oxides of carbon are carbon monoxide, the deadly gas associated with a running automobile engine, and carbon dioxide, the gas associated with the process in nature of photosynthesis.

Carbon also forms other compounds. Carbonate compounds are chemical combinations of carbon with three atoms of oxygen, plus some metal. For example, a common substance found in nature and used in many building products such as marble, limestone, dry wall, and cement is calcium carbonate, $CaCO_3$. The chemical formula shows that this compound is a combination of carbon, oxygen and the metal calcium.

The chemical test for carbon dioxide is to allow the gas under study to bubble through a clear saturated solution of limewater (saturated calcium hydroxide). The chemical test for the carbonate compound (radical) is to react the sample under test with hydrochloric acid. The resultant gas is bubbled through limewater to detect the presence of carbon dioxide.

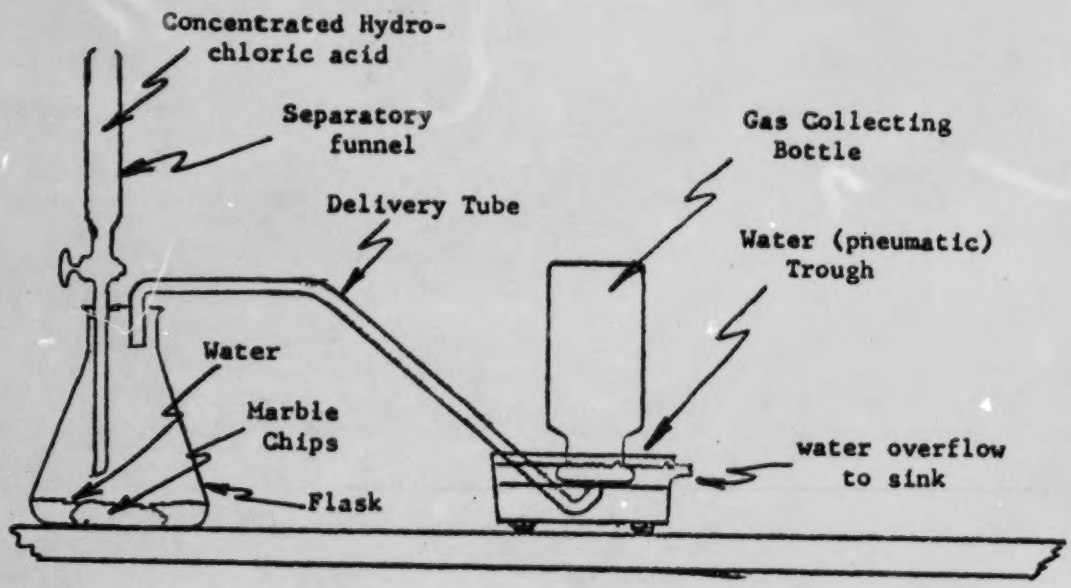
Procedure:

PART ONE.....Pour a few milliliters of limewater into a watch glass and set it aside until the end of the laboratory.

PART TWO.....PREPARATION OF CARBON DIOXIDE

Set up a carbon dioxide generator as shown below. Carbon dioxide is collected, like oxygen, by the downward displacement of water. Cover the bottom of the erlenmeyer flask with a small quantity of marble chips. Add just enough water to

barely cover the chips. Add concentrated hydrochloric acid, a drop at a time to cause a steady flow of gas. Allow the gas to bubble through the water in the pneumatic trough for about a minute to allow the air to be flushed from the delivery tube. Collect four bottles of carbon dioxide. Be sure the glass plates are firmly in place and store the bottles right side up.



Carbon Dioxide Generating Assembly.

PART THREE.....WHAT ARE SOME OF THE PROPERTIES OF CARBON DIOXIDE?

1. Hold a piece of very white paper behind a bottle of the gas collected from Procedure 1. What is the color of the gas? Remove the glass plate and describe its odor. Describe your results in the data sheet.

2. Pour about 15 ml. of limewater into a test tube. Using a rubber extention of the delivery tube, allow the gas from the generator to bubble through the limewater. Describe the results in your data sheet.

3. Add about 10 ml. of distilled water and a few drops of red phenolphthalein solution to a bottle of the gas collected. Stopper and shake well. Describe the result.

4. Rinse a clean gas collecting bottle in the water of the pneumatic trough. Do not dry the bottle. After a few minutes, test the air in the bottle using the same procedure as in 2c above. Describe the result in your data sheet.

Title: LAB--Oxides of Carbon

PART FOUR.....TEST FOR A CARBONATE COMPOUND (RADICAL)

Set up an apparatus like that used in Procedure 1, except replace the marble ships with a piece of chalk, sea shells or any carbonate compound. Add water and hydrochloric acid as in Procedure 1. Describe the result in your data sheet.

PART FIVE.....OTHER SOURCES OF CARBON DIOXIDE

1. Burn a wood splint or paper in a beaker containing nothing but air. Pour 10 ml. of limewater into the beaker, cover, and shake well. Describe the result. Repeat the above test in a beaker in which no burning has occurred. Result?

2. Place five to ten ml. of fresh limewater into a test tube. Using a piece of glass tubing as a mouthpiece, gently exhale your breath through the limewater. Describe the result.

3. Examine the limewater in the watch glass set aside at the beginning of the laboratory period. Result?

Trade Relatedness:

1. Draw an illustration of the soda-acid free extinguisher. Explain its operation. Why is the use of this type of extinguisher dangerous for electrical fires? Is this type of extinguisher effective on oil or gasoline fires? Why?

2. Draw a "flow diagram" of the Solvay process and list the products and by-products obtained.

3. Explain how "dry ice" is made and why it is an effective refrigerant.

Conclusions:

1. Describe the test for carbon dioxide.

2. Describe the test for the carbonate radical.

3. List five sources of carbon dioxide.

4. Explain the process of photosynthesis and how it is important to the ecology and environment. Explain the derivation of the word photosynthesis.

5. List two reasons why carbon dioxide is an effective fire fighting material. What type of fire is it not effective against?

6. What would a solution of carbon dioxide and water taste like?

7. What physical property of carbon dioxide allows it to use downward displacement of water to collect the gas?

8. Carbon dioxide dissolves in water to form carbonic acid which can react with limewater, clacium hydroxide, to form a white precipitate_____.

9. Carbon monoxide and carbon dioxide (in sufficient quantity) can both kill. Explain how the lethal effects of the two gases differ.

Clean up. Thoroughly wash all laboratory equipment and glassware in strong soap and water solution. Glassware must be thoroughly rinsed. Remember: A place for everything and everything in its place. Leave the laboratory area in the same condition as you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

MOLECULAR

OXYGEN

LABORATORY INVESTIGATION OF MOLECULAR OXYGEN

INTRODUCTION

The term "molecular oxygen" is used to emphasize the diatomic nature of free oxygen gas as opposed to oxygen in compounds such as water.

A summary of the characteristics and properties of oxygen is listed below:

Occurence

20% of the volume of air

88% of the weight of water

50% of the earth's crust

Important part of all living tissue

Properties of Oxygen

Physical - colorless, tasteless, odorless, and slightly soluable in water.

Chemical - combines with most other elements, and supports combustion.

Uses of Oxygen

Kills bacteria

Sustains and supports life

Supports combustion

Enhances taste

Title: LAB--Determination of the Best Materials for the Preparation of Molecular Oxygen

Unit: Molecular Oxygen

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB. ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To determine the materials best suited for the laboratory preparation of oxygen.

Materials Required:

High temperature laboratory burner, ignition tube (large hard-glass test tube will work), burrette clamp, ring stand, wood splints, calcium carbonate, $CaCO_3$., lead oxide, PbO, lead dioxide, PbO_2, zinc oxide, ZnO, copper oxide, CuO, magnesium oxide, MgO, ferric (iron) oxide, Fe_2O_3.

Information:

Oxygen is rarely found in a free (uncombined) state in nature. That is, oxygen readily combines chemically with other elements, both metallic and non-metallic, to form "oxides". Therefore, if one desires to make pure oxygen in the laboratory, he must cause the oxygen that is chemically combined within a material to separate. The separation of a compound into its parts is called "decomposition".

Procedure:

Precautionary Note: The ignition tube must be clean and dry both inside and outside. When you begin to heat the tube, gently play the flame back-and-forth along the entire length of the tube. Do this about one minute to gradually raise the temperature of the tube.

1. Do all oxides decompose when heated?

2. Crease a piece of smoothly finished paper lengthwise to form a funnel. One-quarter piece of good quality notebook paper, smoothly cut with scissors, works well. Measure onto the paper about 0.5 gram of calcium carbonate.

3. Using the creased paper as a funnel, deposit the chemical into the ignition tube. (The student may wish to review the procedures for handling solid reagents).

Title: LAB--Determination of the Best Materials for the Preparation of Molecular Oxygen

4. Holding the ignition tube in almost a horizontal (level) position, roll the tube back and forth so as to distribute the chemical along the bottom of the tube and make an "air space" above the chemical.

5. Assemble the apparatus as shown in Figure 1, being certain to maintain the correct angle of the ignition tube and the air space above the material.

6. Reread the precautionary note in the beginning of the procedure, then begin heating the ignition tube. Heat the tube and material strongly for a few minutes, constantly checking for the presence of oxygen gas. Note: The test for oxygen gas is a glowing splint (not a burning splint).

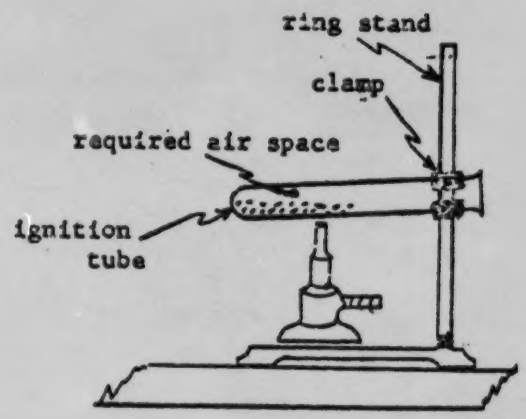


Fig. 1. Ignition tube apparatus illustrating proper angle of the tube and the required air space above the material

7. Carefully observe any change in the appearance of the heated material. Record the results of your observations in the data sheet.

8. Repeat steps 2 through 7 for each material listed in the materials required.

Clean up. Thoroughly wash all laboratory equipment and glassware with a strong soap and water solution. Report any broken glassware or equipment to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the kind of condition that you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Technical Relatedness:

1. Zirconium oxide, a chemical combination of zirconium and oxygen, has a high melting point, conducts heat poorly, and does not decompose even when heated to the highest possible temperature obtainable from a laboratory burner. Zirconium oxide is sometimes used as the material in the manufacture of crucibles for this reason.

Title: LAB: Determination of the Best Materials for the Preparation of Molecular Oxygen

2. What properties of magnesium oxide make it useful as a furnace or refractory lining?

3. Magnesium metal is simpler to shape by machining and to make into furnace linings than is magnesium oxide. Why are manufacturers forced to use the oxides rather than the metal for such purposes?

4. Aluminum oxide is used as an abrasive in grinding wheels. Is the temperature of the sparks coming from the wheel when grinding steel, hot enough to decompose the aluminum oxide or melt the wheel? How can you be sure of your answer? Do some research outside of class into the properties of types of grinding wheels.

Conclusions:

1. Carefully observe the formulas for each of the oxides used in this experiment to discover the relationship between the number of oxygen atoms and the readiness to decompose. Explain what you find.

2. Which of the substances you tested appears to have the best ability to give up its oxygen upon heating? Why did you choose this material? How many atoms of oxygen does it have in the compound?

Title: LAB--The Determination of the Best Materials for the Preparation of Molecular Oxygen

PAGE FOUR

DATA SHEET

Material to be Heated		Ability to Decompose When Heated	Observations of Appearance	
Name	Formula		Before Heating	After Heating

Title: LAB--Generation of Oxygen and Study of the Physical Properties of Oxygen Gas

Unit: Molecular Oxygen

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB. ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To generate some oxygen by a new method, then observe its physical properties.

Materials Required:

Separatory funnel, 50 ml; Erlenmeyer flask, 500 ml. fitted with a two-hole stopper; laboratory balance, four (4) gas collecting bottles, small; glass plates large enough to cover the mouth of the gas collecting bottles; glassstirring rod; pneumatic (water) trough equipped with shelf for holding gas collecting bottles; ring stand; burrette clamp; hydrogen peroxide, H_2O_2, 3%; Manganese dioxide, MnO_2, powder.

Information:

Prerequisite: Knowledge of the laboratory process of the collection of gas over water (downward displacement of water).

We identify a material by observing its characteristics. Characteristics of a substance are called properties and are grouped into the physical properties and the chemical properties. If someone were trying to find a friend he might ask a passerby if he had seen a person with blond hair, blue eyes, five feet two inches tall and weighing 115 pounds. These features, or characteristics, would identify the person. Likewise, in chemistry the characteristics of a substance are those features by which we may identify the substance. For example, we can identify gold by its weight and its yellow color. Properties are divided into physical properties and chemical properties.

Procedure:

PART ONE.....COLLECTION OF OXYGEN GAS FROM THE DECOMPOSITION OF HYDROGEN PEROXIDE USING MANGANESE DIOXIDE AS A CATALYST.

1. Cover the bottom of the Erlenmeyer flask with powdered manganese dioxide.

2. Assemble the equipment as shown in the figure on Page Two. Securely clamp both the separatory funnel and the Erlenmeyer flask.

Title: LAB--Generation of Oxygen and the study of the Physical Properties of Oxygen Gas

3. Make certain that the stopcock on the separatory funnel is closed, then fill the reservoir of the funnel about two-thirds full with 3% hydrogen peroxide solution. Suggestion: Before filling the funnel with H_2O_2, practice dropping water one drop at a time, over the sink. Dry the funnel before filling.

4. Fill the gas collecting bottles with water, cover with a glass plate and invert one bottle in the water trough. Do not place the bottle over the output of the delivery tube.

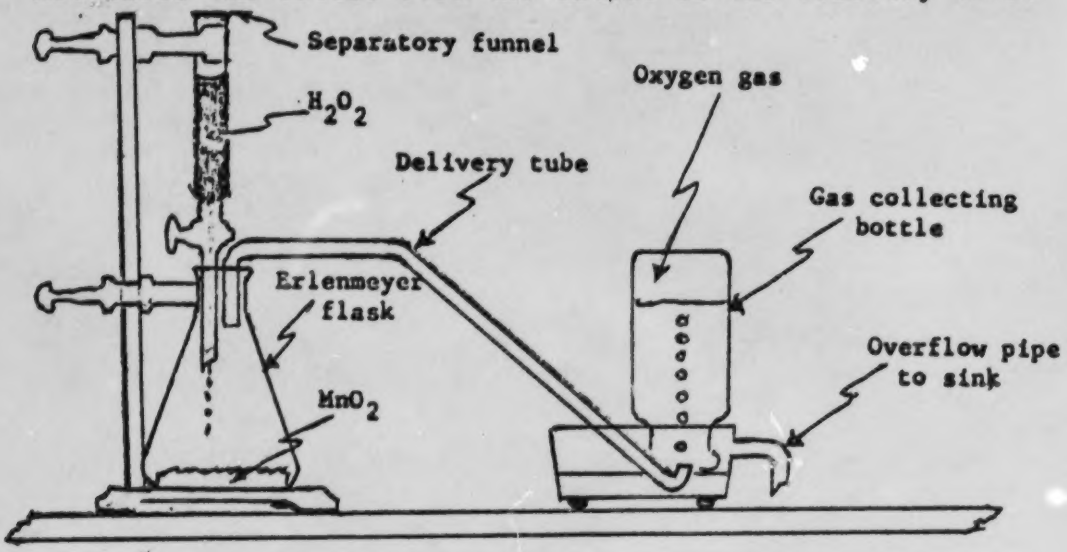


Figure 1. Apparatus set up for the generation of oxygen from the decompostion of hydrogen peroxide.

5. Begin the generation of the gas by allowing the hydrogen peroxide to flow, a drop at a time, onto the manganese dioxide. After the gas buttles out of the delivery tube for a few seconds, place the gas collecting bottle over the output and collect your bottles of gas.

PART TWO.....DETERMINING THE PHYSICAL PROPERTIES OF OXYGEN

1. Thoroughly wash and rinse a glass stirring rod. Dry the rod then rinse again with distilled water. Remove the glass plate from a bottle of oxygen and hold the moistened rod in the bottle. Be certain that a drop of distilled water is on the end of the rod. Do not allow the rod to touch the sides or bottom of the bottle.

Title: LAB--Generation of Oxygen and the Study of the Physical Properties of Oxygen Gas

2. After holding the moistened glass rod in the oxygen for several minutes, carefully remove the rod and bring the tip of the rod to the tip of your tongue. Record your observations. Explain how this could be a taste test for oxygen.

3. With the glass plate in place, bring a bottle of oxygen up to your nose. Remove the glass plate and smell the gas. Record your observations in the data sheet.

4. Hold a piece of clean white paper behind a bottle of oxygen. Observe any color of the gas. Record your observations.

5. Using a laboratory balance accurate to at least 0.01 grams, measure the mass of a bottle of oxygen. Empty the oxygen and allow the bottle to fill with air. Measure the mass of the identical bottle of air. Record your measurements and observations in the data sheet.

6. Record any evidence you may have in regard to the solubility of oxygen in water.

Clean up. Thoroughly wash all laboratory equipment and glassware with a strong soap and water solution. Report any broken glassware or equipment to your instructor. Remember: A place for everything - everything in its place. Leave the lab area in the kind of condition that you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Conclusions:

1. Prepare a list of the physical properties of oxygen. Include in the list all those physical properties tested in the laboratory as well as other physical properties you may find in references.

2. Write a complete definition of the term "physical property".

3. Write a complete definition of the term "chemical property".

Title: LAB--Laboratory Preparation of Oxygen

Unit: Molecular Oxygen

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To prepare oxygen in the laboratory by the decomposition of potassium chlorate.

Materials Required:

Burrette clamp, ignition tube, ring stand, pneumatic (water) trough with shelf, gas collecting bottles, small, four; glass plates, one-hole stopper to fit the ignition tube, pipestem triangle of suitable size to support crucible, crucible and cover, laboratory burner, miscellaneous glass and rubber tubing to construct the delivery tube, wood splints, magnesium ribbon, manganese dioxide, MnO_2, potassium chlorate, $KClO_3$, fine grade steel wool, citric acid (vinegar will work), glass wool.

Information:

Potassium chlorate will decompose into potassium chloride and oxygen gas. This reaction will proceed moderately without a catalyst, but the resulting gas pressure is indufficient to collect oxygen gas over water (the downward displacement of water). The addition of a catalyst, manganese dioxide, will cause the reaction to proceed at a more satisfactory rate.

CAUTION: Manganese dioxide has a tendency to pick up foreign materials and in the presence of rich oxygen atmosphere, will readily burn causing a potentially hazardous situation. Manganese dioxide should be heated strongly in a closed crucible for ten minutes before being used in this experiment.

Procedure:

It is necessary that the student understand the following operations before attempting this laboratory. This laboratory is potentially dangerous. $KClO_3$ should not be crushed.

1. Correct operation of a laboratory burner.
2. Correct assembly of a delivery tube and a pneumatic (water trough.
3. Correct method of preparing gas collecting bottles for the collection of gas by the water displacement method.

Title: LAB--Laboratory Preparation of Oxygen

4. The knowledge of the test for oxygen gas.

The student must review these operations with the instructor before attempting the laboratory.

PART ONE.....PREPARATION OF OXYGEN GAS

1. Obtain a quantity of manganese dioxide and heat it strongly in a closed crucible for at least ten minutes. While this is heating proceed with setting up other equipment.

2. Assemble the apparatus as shown in the figure on Page Four. CAUTION: Molten potassium chlorate in contact with rubber stoppers will burn in a rich oxygen atmosphere. Carefully note how the rubber stopper in the ignition tube is protected from the molten potassium chlorate by the insertion of a small glass wool plug. This step is a necessity.

3. After the delivery tube is assembled check the completed apparatus to be certain that there are no obstructions. Any blockage to the free flow of gas through the delivery tube will cause the ignition tube to blow up.

4. Fill the gas collecting bottles and water trough with water. The output spout of the water trough should be fitted with a piece of rubber tubing so as to allow overflow water to drain into the sink. Invert a gas collecting bottle on the shelf of the water trough, but, not over the output of the delivery tube.

5. Turn off the gas and remove the manganese dioxide. When cool enough to handle, accurately measure 1.5 grams of manganese dioxide onto a piece of folded paper. Accurately measure 8.0 grams of potassium chlorate, $KClO_3$, onto the same piece of paper with the manganese dioxide. Note: Read labels carefully. There is a common laboratory chemical called potassium chloride. Do not use the wrong reagent. READ CAREFULLY!!!

   Thoroughly mix the potassium chlorate and the manganese dioxide and pour the mixture into the ignition tube. Holding the tube almost horizontally, roll the tube back and forth so as to distribute the mixture along the bottom of the ignition tube and to create the required airspace above the mixture. Holding the ignition tube almost horizontal, clamp the tube onto the ring stand and complete the assembly of the apparatus.

6. Do not begin heat. DO NOT BEGIN THE PREPARATION OF THE OXYGEN GAS UNTIL YOU HAVE OBTAINED YOUR INSTRUCTOR'S APPROVAL. INSTRUCTOR'S INITIALS_____.

7. Upon obtaining your instructor's approval, begin heating the mixture. Allow some of the gas to evolve from the delivery tube before placing the inverted gas collecting bottle over the output of the delivery tube. Collect four bottles of the gas, covering each one with a glass plate. Without disturbing the glass plate, dry the outside of the gas collecting bottles as well as you can.

8. Note: Do not stop heating the ignition tube until the delivery tube is disconnected or removed from the water. After you have collected the four bottles of gas, disassemble the delivery tube from the ignition tube, then turn off the burner. Save the residue in the ignition tube.

PART TWO.....TESTING FOR OXYGEN

1. Insert a glowing splint into one of the bottles of oxygen. Record your observations in the data sheet.

2. CAUTION: Do not look directly at burning magnesium ribbon. Damage to your eyes may result. Hold a piece of magnesium ribbon with tongs. Ignite the ribbon with a burner and immediately insert the burning ribbon into a bottle of oxygen. Record your observations. Carefully examine the remains of the ribbon after it has burned out. Record your observations.

3. Clean a small piece of steel wool with acetic acid (vinegar). Rinse with water and dry the sample as much as possible. Holding the steel wool with tongs, heat the wool in a burner flame strongly until you think the steel is hot. Quickly insert the wool into a fresh bottle of oxygen gas. Examine the residue of the burnt steel wool and record your observations.

4. Perform any other experiment for the test of oxygen gas as may be approved or directed by your instructor.

5. Examine the residue of the ignition tube. Describe its appearance,. Is the residue a mixture or a compound? How can you use your knowledge of how to separate a mixture to determine the characteristics of the residue?

6. Perform an experiment on the residue and record your observations.

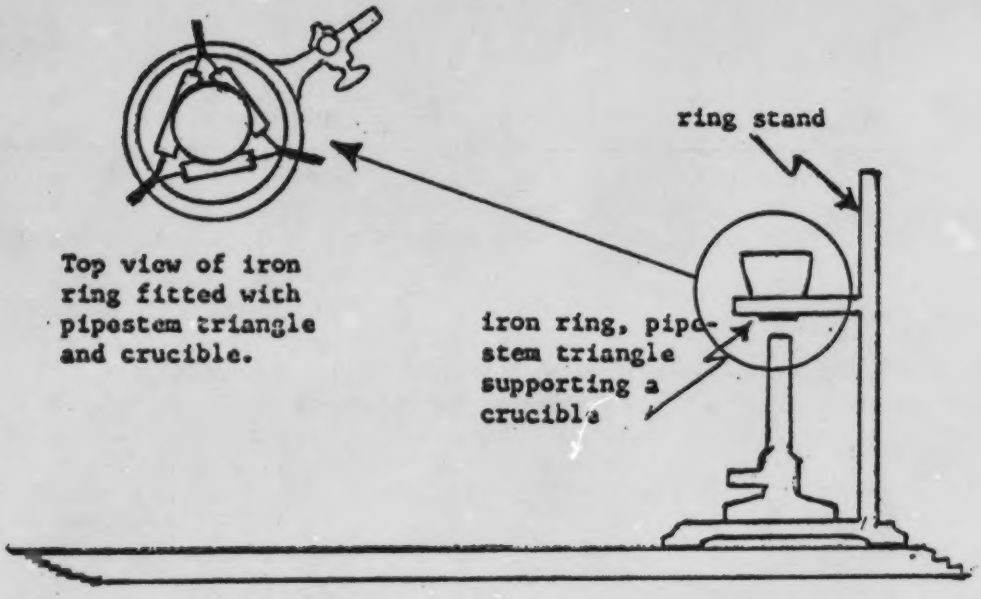

ring stand
Top view of iron ring fitted with pipestem triangle and crucible.
iron ring, pipe-stem triangle supporting a crucible

Figure 1. Arrangement of apparatus for heating manganese dioxide to drive off impurities.

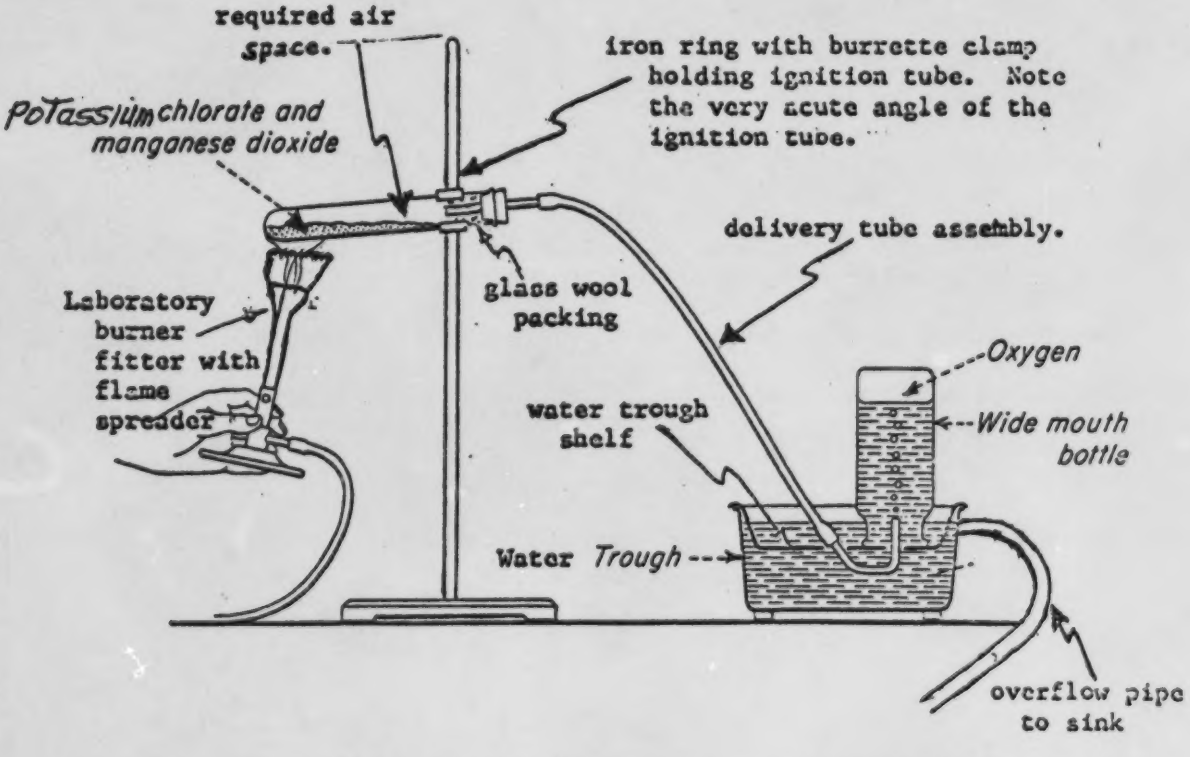

required air space.
iron ring with burrette clamp holding ignition tube. Note the very acute angle of the ignition tube.
Potassium chlorate and manganese dioxide
delivery tube assembly.
glass wool packing
Laboratory burner fitter with flame spreader
Oxygen
Wide mouth bottle
water trough shelf
Water Trough
overflow pipe to sink

Figure 2. Laboratory setup for the preparation of oxygen from the decomposition of potassium chlorate.

Clean up. Thoroughly wash all laboratory equipment and glassware. Report any broken apparatus to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the same condition that you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Trade Relatedness:

1. Oxyacetylene is a common form of welding. The gas used in oxyacetylene welding is a mixture of oxygen and acetylene. You will work with acetylene later in this course.

2. List as many applications of oxygen to your trade area, or to any manufacturing or industrial process in which you may be interested.

3. Explain how the burning of steel wool in oxygen in your experiment illustrates an important industrial process in the manufacture of iron and steel.

4. Explain how oxygen gas is obtained in very large quantities for the various operations in industry and space.

Conclusions:

1. Define a catalyst.

2. Why must the delivery tube be disconnected before removing the heat from the ignition tube?

3. In general, how does the presence of oxygen appear to affect the burning of substances?

4. Describe the common test for the presence of oxygen.

5. Is the oxygen gas collected in this experiment pure? If not, list the impurities to be found with the oxygen and explain where they came from.

6. Why is it possible to use the water displacement method to collect oxygen gas? List a gas which cannot be collected over water.

7. List two other methods of obtaining osygen in the laboratory.

Title: LAB--Laboratory Preparation of Oxygen

PAGE SIX

DATA SHEET

Operation	Observation
Basic test for oxygen	
Burning magnesium ribbon	
Magnesium ribbon residue	
Burning Steel wool	
Steel Wool Residue	
Other test for oxygen	

Title: LAB--Laboratory Investigation of the Chemical Properties of Oxygen

Unit: Molecular Oxygen

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB. ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To provide a fundamental knowledge of the chemical properties of oxygen.

Materials Required:

Gas collecting bottles, small, four; water trough; separatory funnel, 50 ml.; Erlenmeyer flask, 500 ml. fitted with a two-hole stopper; laboratory burner; iron ring; wire gauze; 250 ml. beaker; flask, Erlenmeyer, 125 ml.; miscellaneous glass and rubber tubing to fabricate a delivery tube; stick charcoal (carbon); magnesium ribbon; sodium peroxide; limewater; wood splints; litmus paper, red and blue; phenolphthalein solution, colorless and red.

Information:

Prerequisite: Knowledge of how to collect oxygen gas by the water displacement method, and proper operation of a bunsen burner.

Oxygen readily combines with metals and nonmetals to form oxides. The water solutions of nonmetals form acidic solutions and the water solutions of metals form basic solutions.

Procedure:

PART ONE.....THE GENERATION AND COLLECTION OF OXYGEN GAS

1. Set up the laboratory apparatus as shown in the figure on Page Two. Be certain to clamp all equipment securely.

2. Collect four bottles of oxygen gas by the downward displacement of water. Without moving the glass plates, dry the outside of the gas collecting bottles as well as possible.

3. Save the residue in the flask for a later experiment.

Title: LAB--Laboratory Investigation of the Chemical Properties of Oxygen

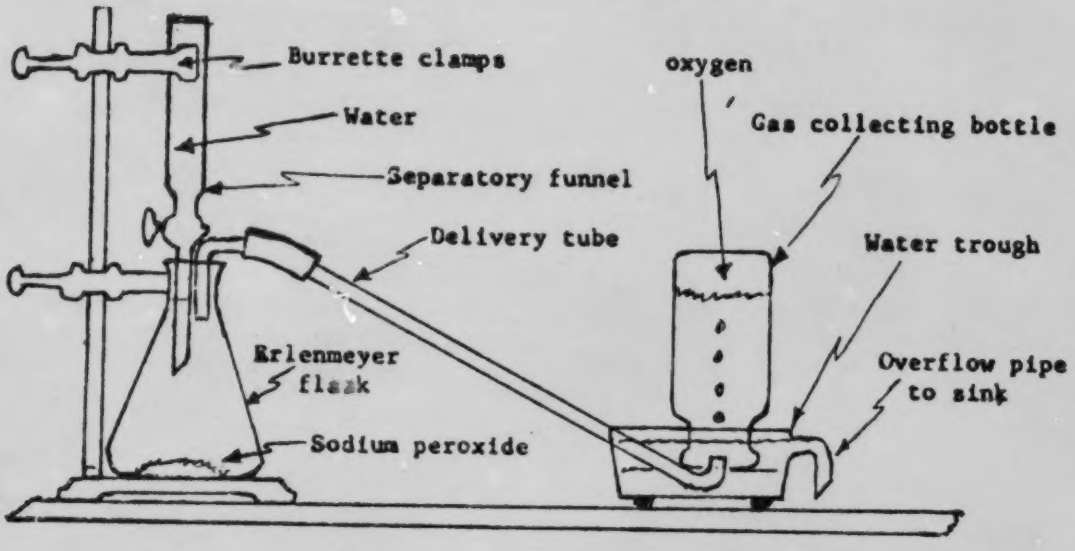


Figure 1. Apparatus set up for the generation of oxygen gas from the decomposition of sodium peroxide.

PART TWO.....TESTING FOR THE CHEMICAL PROPERTIES OF OXYGEN

1. Light a wood splint and hold an inverted bottle of oxygen over the burning splint. Remove the glass plate. Record your observations. Does oxygen burn?

2. Heat a small length of stick charcoal in a burner flame until the charcoal begins to burn. Quickly insert the burning charcoal into a bottle of oxygen. Record your observations. When the burning stops, pour 25 ml. of limewater into the bottle. Replace the glass plate and shake the bottle to mix the limewater and the gases. Record your observations.

3. Using tongs, place a piece of calcium oxide (quicklime) in an Erlenmeyer flask containing 25 ml. of distilled water. Mix thoroughly. Using a glass rod transfer a few drops of this solution to litmus paper. Record your observations. Test the solution with colorless phenolphthalein solution. Record your observations. Is the solution of calcium oxide in water acidic or basic?

Title: LAB--Laboratory Investigation of the Chemical Properties of Oxygen

4. Obtain a 10 cm. length of magnesium ribbon and burn it in a crucible. After burning ceases, transfer the remaining white solid to a beaker containing 10 ml. of distilled water. Heat the water to boiling in order to dissolve as much of the material as possible. What is the name of the compound formed by the burning of magnesium ribbon in air? Using the same type of tests in 3 above, determine whether the solution is acidic or basic. Record your observations.

5. Obtain a piece of sulfur about the size of a pea and place it in a deflagrating spoon lined with asbestos paper. Apply heat from a bunsen burner until the sulfur ignites. Lower the spoon and burning sulfur into a wide-mouth gas collecting bottle containing 25 ml. of distilled water. Be careful not to touch the water with the spoon. Without removing the spoon, cover the bottle as well as possible with a glass plate. After a few minutes, remove the sulfur, cover the bottle tightly with the glass plate and shake well to dissolve as much of the gases as possible. Use a glass rod to transfer a few drops of the solution to red and blue litmus paper. Describe your observations. Divide the remaining solution into two equal volumes. Test each sample using colorless phenolphthalein on one sample and red phenolphthalein on the other. Describe your results.

6. Using the phenolphthalein and litmus tests, test the residue in the generating flask. Is the residue basic or acidic? Record your observations.

Clean up. Thoroughly wash all laboratory equipment and glassware with a strong soap and water solution. Glassware must be thoroughly rinsed. Report any broken equipment or glassware to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the kind of condition that you would like to find it. Have consideration for your fellow classmates who also have to use the laboratory.

Trade Relatedness:

1. Explain how one can use baking soda to eliminate the harmful effects of burns from battery acid.

2. Explain how oxygen is prepared commercially in today's rapidly expanding industrial scene.

3. Explain how oxygen reactions are important to some aspect of the activities in your trade area.

Title: Lab--Laboratory Investigation of the Chemical Properties of Oxygen

Conclusions:

1. What kind of solutions are formed from the water solutions of non-metallic oxides?
2. Describe two tests for acidic solutions.
3. What kind of solutions are formed from the water solutions of metallic oxides?
4. Describe two chemical tests for basic solutions.
5. What is the chemical test for carbon dioxide used in this lab?
6. Describe four methods in which relatively pure oxygen may be prepared in the laboratory.
7. When substances burn in air (oxygen) what type of compounds are formed?
8. The elimination of sulfur dioxide from the air is an important part in reducing atmospheric pollution. Explain why and how it is important, and list some possible sources of sulfur dioxide.

Title: LAB--Laboratory Investigation of the Chemical Properties of Oxygen

DATA SHEET FOR CHEMICAL PROPERTIES OF MOLECULAR OXYGEN

Operation	Observation
A. Does oxygen burn in air?	
B. Burning carbon in oxygen.	
C. Water solution of calcium oxide.	
D. Burning magnesium in oxygen	
E. Burning sulfur in oxygen	
F. Testing residue of sodium peroxide.	

Title: LAB--Laboratory Investigation of the Chemical Properties of Oxygen

INSTRUCTOR'S NOTES

Due to the use of sodium peroxide this lab is recommended as a demonstration by the instructor.

COMMENTS:

WATER

LABORATORY INVESTIGATION OF WATER

INTRODUCTION

Water is a very common compound. 71.8% of the earth's surface is covered with water to an average dept of 2.5 miles, yet it is vital to your life. About 70% of your blood is water, vegetables rank as high as 90% water, 70% of meat is water and your body tissue contains water. Water is so common that we loose our respect for its value until we run out of it.

Title: LAB--Laboratory Investigation of Water

Unit: Water

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To provide basic knowledge of how to prepare chemically pure water and to analyze the product to determine some physical properties.

Materials Required:

Flask, sidarm (or Erlenmeyer flask fitted with a two-hole stopper); ring stand; iron ring; wire gauze; burrette clamp; thermometer; Leibig condenser; tripod stand; beaker, large for heat sink; beaker, small, receptacle for distillate; laboratory burner; impurities (dirt, colored water, potassium permanganate, etc.); ammonium hydroxide, 3N; phenolphthalein, colorless.

Information:

Water, a chemical combination of hydrogen and oxygen, is a polar molecule and thus is a very good solvent for many substances, especially inorganic matter. Thus, the waters of the earth are not "pure".

Pure water is not the same as drinkable (potable) water. Pure water contains nothing but hydrogen and oxygen atoms, and a steady diet of only pure water is not good for your health. Potable water is water that contains minerals and other matter, but is safe to drink. It is the mineral content that is important to your health. Because the minerals contained in the water are the result of the physical process of solvent action of the water molecule, you are able to separate the water molecules from the impurities by the simple physical process of distillation.

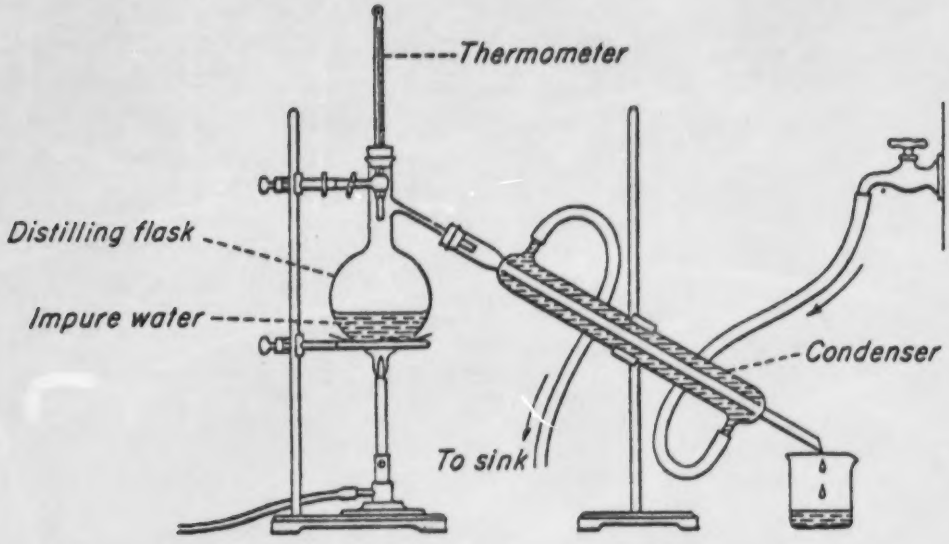
Procedure:

PREPARATION OF DISTILLED (PURE) WATER

1. Set up the apparatus as shown on Page Two. Note: The direction of the water flow into the condenser is important. Be certain the hose connections are tight. Suggestion: secure hose connections to the condenser with "twisties". Use only a low rate of water flow.

Title: LAB--Laboratory Investigation of Water

PAGE TWO



2. Place impurities in the distillation flask and fill to about one-third full of tap water. Attach the delivery tube. Note: the delivery tube should be a single length of glass. Begin heating the water as soon as possible. When moisture begins to appear on the neck of the flask or the delivery tube, reduce the heat to just enough to cause the water to simmer. You do not want the water to boil rapidly. Read and record the temperature of the apparatus in degrees centigrade._____. Read and record the atmospheric pressure._____.

3. Collect about 15 ml. of distillate. Remove the receptacle and replace it with another clean receptacle. Continue the distillation.

4. Using a thoroughly clean glass rod, transfer a few drops of the distillates to both red and blue litmus paper. Record your findings. Using a thoroughly clean glass rod, bring a drop of the distillate to the tip of your tongue. Record your observations. Hold a clean piece of white paper behind the water sample. Record the color of your sample.

5. (Optional). If equipment is available, record the electrical conductivity of your distillate sample.

6. Freezing point. In a large beaker, set up a brine solution of salt and ice. The temperature of the brine should be approximately -3.0° centigrade (celsius). Leaving the distillate in its own container, emerse the distillate into the brine solu-

tion. When ice crystals begin to form, measure the temperature of the distillate to the nearest 0.1 degree celsius. Record your measurement.

7. Boiling point. Dry the outside of the container containing the distillate. Set up an iron ring, wire gauze, ring stand and bunsen burner. Heat the distillate until it begins to boil. Measure the temperature of the sample to the nearest 0.1°C. Record your reading. Read and record the barometric pressure.

8. On separate watch glasses, place three drops of distillate from the receptacle, and three drops of tap water. Remove the receptacle and stop the distillation. Evaporate the contents of the watch glasses to dryness by heating the watch glasses over beakers of boiling water. Observe the residue on each watch glass and record your observations.

9. Place about 50 ml. of distilled water in a beaker and add a drop of ammonium hydroxide. To this solution add a drop or two of clear phenolphthalein. Record your observation of the test. This test if to be used as a test for the presence of ammonia in the following experiment.

10. Pour 100 ml. of distilled water into a clean distillation apparatus and add one drop of ammonium hydroxide. Place the solution into position in the distillation apparatus setup. Begin heating the solution. Obtain six small test tubes and place one drop of phenolphthalein in each of the test tubes. Collect about one-third of a test tube of distillate in each of the test tubes in succession. After collecting the distillate in each of the test tubes, wipe the end of the condenser dry before proceeding to the next test tube. Record your observations of each of the six test tubes.

Clean up. Thoroughly wash all laboratory equipment and glassware with a strong soap and water solution. Report any broken glassware or equipment to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the kind of condition that you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Trade Relatedness:

1. Explain why battery manufacturers recommend the use of distilled water in wet cell batteries.

2. Explain why antifreeze (principally ethylene glycol) is dilluted in a 50/50 ratio to obtain maximum protection for the radiator and engine block.

3. Explain why modern antifreeze solutions are also labeled "Summer" coolants. Is this false advertising? Does the solution in the radiator actually cool the engine? Explain your answer fully.

Conclusions:

1. Charles Law for Ideal Gases states that the pressure above a gas is directly proportional to the temperature under the conditions of constant volume. Assuming that the volume at any one time to be constant, calculate the actual boiling temperature of the

   a. contaminated water

   b. distilled water

   Note: Temperatures must be in degrees Kelvin absolute.

$$\frac{T_1}{T_2} = \frac{P_1}{P_2}$$

where

T_1 = the recorded boiling temperature

P_1 = recorded atmospheric pressure

P_2 = standrad stmospheric pressure of 760 mm Hg

T_2 = boiling temperature under conditions of standard pressure.

2. The boiling point of pure water under conditions of standard pressure should be 100°C (373°K). Account for any difference in the value you obtained and the accepted value.

3. The freezing point of pure water is 0°C (273°K). Account for any difference in the value you obtained and the accepted value.

4. Explain the result of your litmus test: that is, is distilled water acidic or basic?

5. Fully explain the distillation process in terms of the kinetic molecular theory. Explain why some substances can be distilled from the water and others cannot. What process, or phenomenon, in nature is similar to the distillation processes in the laboratory.

6. If you were lost in a place without water, how could you use the knowledge obtained in this laboratory to secure drinking water?

7. Given a mixture of liquids of different boiling points, such as crude oil, explain how you could proceed to separate the mixture.

Title: LAB--Laboratory Investigation of Water

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DATA SHEET	
Operation	Observation
Litmus Test Red Blue	
Taste Test	
Color Test	
Conductivity of Electricity Test. (Optional)	
Freezing Point of Pure Water	
Boiling Point of Pure Water	
Difference in Boiling Point of Pure Water & Contaminated Water	
Phenolphthalein Test for Ammonium Hydroxide, NH_4OH.	
Phenolphthalein Test for solution contaminated with NH_4OH.	

Title: LAB--Relationship of Viscosity of Water to Temperature and Other Physical Properties

Unit: Water

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LBA. ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To provide practice in determining time measurements to determine the point of maximum viscosity and maximum density of water.

Materials Required:

Iron ring; wire gauze; laboratory burner; 250 ml. beaker; burrette clamp; pipette, 50 ml.; rubber suction bulb; ring stand; miscellaneous rubber and glass tubing to make an extension for the pipette; ice; distilled water.

Information:

The viscosity of the fluid is directly related to the density and to temperature. Density and viscosity are important physical properties of matter, however, these physical properties in water behave in a peculiar manner.

The peculiar characteristics of water as its temperature approaches 4°C (39.5°F) are due primarily to the way in which the water molecules are "glued" to each other. The electrical polarity of the water molecule tends to become the dominant factor in the behavior of water as its temperature approaches 4°C. Another important physical property of water is its very high heat absorbing ability. Water can absorb more heat energy per cubic centimeter than any common substance.

Prerequisite knowledge.

1. How to read a meniscus.
2. How to correctly fill and empty a pipette.
3. How to correctly operate a laboratory burner to obtain the maximum rate of heating.

Procedure:

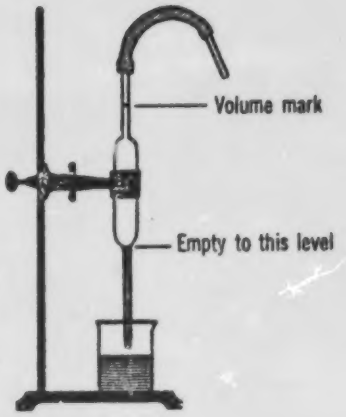
PART ONE.....PREPARATION OF DISTILLED WATER FOR HEATING

1. Obtain a 250 ml. beaker half full of distilled water. Set up the ring stand, iron ring, wire gauze and burner for heating. Heat the water to boiling. Note: Go on to the next step while waiting for the water to boil.

Title: LAB--Relationship of Viscosity of Water to Temperature and Other Physical Properties

PART TWO.....PREPARATION OF THE PIPETTE

1. Set up the apparatus as shown in the illustration. Note; The pipette must be as near vertical as possible.



2. Assemble a short piece of rubber tubing fitted with a short piece of glass tubing, and attach the assembly to the upper stem of the pipette. To the pipette extension assembly attach a rubber suction bulb. Using a china marking pencil, mark a line on the lower stem of the pipette about an inch below the bottom of the wide section. This line will serve as the zero point when emptying the pipette.

3. Using the suction bulb, fill the pipette with tap water to a point well above the volume mark. Squeeze off the rubber tubing, remove the suction bulb, and close the end of the extension with your index finger. Note: This operation must be carried out without the level of the liquid falling below the volume mark. If it does so, you must repeat the filling operation.

4. With great care, allow the level of the water to fall to the volume mark by ever-so-slightly easing the pressure of your finger from the end of the extension. When the level of the meniscus is <u>exactly</u> at the volume mark, immediately close off the pipette. At a convenient point on the clock, simultaneously release your finger from the pipette extension allowing the water to flow and time the action until the level of the liquid exactly reaches the zero mark you made on the bottom stem of the pipette. Repeat this procedure several times until you can do it very accurately.

PART THREE.....MEASUREMENT OF VISCOSITY

1. Rinse the pipette with the boiling distilled water. Some water will remain in the tip of the pipette, however, this is normal. Measure the temperature of the beaker of water to the nearest 0.1°C. Record your measurement.

2. Fill the pipette in the manner prescribed above and allow the liquid to fall to the volume mark. Catch the water in the supply beaker. Note: The bottom tip of the pipette must be above the liquid surface in the beaker when emptying.

Title: LAB--Relationship of Viscosity of Water to Temperature and Other Physical Properties

PAGE THREE

3. Read the time required for the water to flow to the zero mark. Record your answer in the data table. If time allows, make two measurements and average the results.

4. Repeat the steps above for each of the temperatures of water indicated in the data table.

DATA TABLE

Practice Data (times)	Water Temperatures	Time, seconds		
		1	2	average
	1. Boiling, °C			
	2. Hot, 75°C			
	3. Warm, 50°C			
	4. Room Temperature, 20°C			
	5. Cool, 10°C			
	6. At temperature of greatest density, 4°C			

Clean up. Thoroughly wash all laboratory equipment and glassware, with a strong soap and water solution. Glassware mast be thoroughly rinsed. Report any broken glassware or equipment to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the kind of condition that you would like to find it. Have consideration for your fellow classmaste who also must use the laboratory.

Trade Relatedness:

1. The grade of oil used in automobiles and for other lubrication purposes, is rated in terms of viscosity.

   a. Define the term viscosity.

   b. What viscosity of oil would you want to use in your car in winter weather?_____ In summer?_____.

2. Which has the greatest viscosity? (liquids or gases)_____.

3. What relationship does viscosity have to lubrication and the reduction of friction?

4. As temperature of a liquid increases the viscosity of the material (increases, decreases). Explain your answer.

5. As temperature of a gas increases the viscosity of the material (increases, decreases). Explain your answer.

Conclusions:

1. Prepare a graph of temperature in degrees celsius vs viscosity. Plot the temperature along the horizontal axis and the viscosity in seconds along the vertical axis.

2. Answer the following questions by referring to the laboratory observations and the graph plotted in "1" above.

   a. At what temperature does the water flow most rapidly from the pipette?

   b. Explain what happens to the viscosity of water as the temperature increases from 20°C to 100°C.

   c. Explain what happens to the viscosity of water as the temperature decreases from 25°C to 0°C.

   d. At what temperature is the viscosity the greatest?

3. A decrease in temperature would result in a (an) (decrease, increase) in the kinetic energy (energy of motion) of the water molecules.

4. A decrease in the kinetic energy of the water molecules results in (smaller, larger) distances between molecules.

5. Molecular attraction, due to bonding and other forces, would (decrease, increase) as the molecules move closer together.

6. Briefly explain why the viscosity of water may be expected to change as observed when the temperature of the water decreases.

Title: LAB--Electrolysis of Water

Unit: Water

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To analyze water to prove it is made of exact proportions of hydrogen and oxygen, and perform tests to prove which of the gases evolved is hydrogen and which is oxygen.

Materials Required:

Hoffman electrolysis apparatus; variable voltage direct-current power source; bunsen burner; small hard glass test tubes; dilute sulfuric acid (H_2SO_4); wood splints

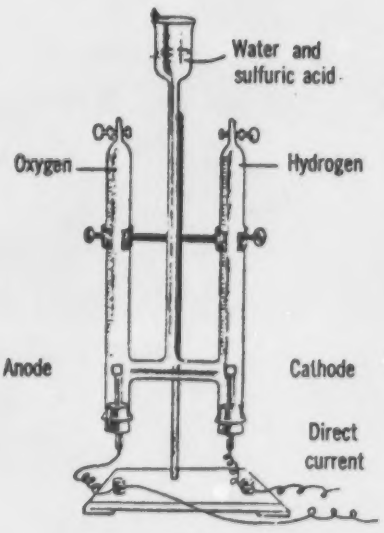
Information:

Using a Hoffman apparatus, you will determine the qualitative (the parts of) and quantitative (the quantity of each part) composition of water by the volumetric method. You will determine the relative conductivity of pure water and acidic water (that is, water to which a small amount of acid has been added).

Procedure:

PART ONE.....HOFFMAN APPARATUS

Disassemble the Hoffman apparatus and thoroughly clean all glass parts with a strong solution of soap and water. Thoroughly rinse all parts of the apparatus. Be sure the hole in the stopcock is clean and free of excess grease. Remove all corrosion, contamination and other dirt. Reassemble the apparatus. Note: Platinum electrodes are fragile. Do not attempt to straighten the metallic parts of the electrodes. Handle them with extreme care. Use the electrode in the condition in which you receive it. It will not affect the results of the experiment. Obtain two platinum electrodes and install them into the apparatus.



In this apparatus water is decomposed by electrolysis into two volumes of hydrogen for each volume of oxygen.

Title: LAB--Electrolysis of Water

PAGE TWO

PART TWO.....EXAMINATION OF THE RELATIVE CONDUCTIVITY OF LIQUIDS

1. Completely assemble the apparatus as shown in the illustration on Page One. Fill the assembly with tap (potable) water to a level equal to the 35 ml. mark on both the outside tubes (eudiometer tubes). Note: If the stopcocks are not open or if the stopcocks are clogged, the water will not rise in the tubes or the levels in the tubes will not be equal. Connect the leads of the power supply to the terminals at the base of the ring stand. Turn the power control to the maximum counter-clockwise position (minimum voltage). Connect the power cable to the AC outlet. Turn the control to the maximum clockwise position (maximum voltage). Make very careful observations of the eudiometer tubes. Be patient and look at the tubes carefully. Record your observations in your data sheet.

2. Disconnect the power supply. Add dilute sulfuric acid (H_2SO_4) to the center thistle tube until the level of the water in both of the outside eudiometer tubes is exactly zero. Note the tube calibrations are labeled "zero" at the top and "60 ml" at the bottom. DO NOT OVERFILL. Close the stopcocks. Reconnect the power supply and carefully observe the resultant action in each of the eudiometer tubes. Record your observations in the data sheet. Note: Your observations should include each eudiometer tube, the thistle tube and the area around the electrodes. Disconnect the power supply.

3. Related questions. (These questions are not to be answered during the laboratory period. They are included at this point in the lab procedures for the purpose of clarity and simplicity).

   a. What conclusion can you now make about the relative conductivity of tap water as opposed to acidic water?

   b. Is the acid absolutely required for water to conduct electricity? Why? Think of a way in which you may be able to prove your point.

   c. The positive electrode is called the _____ and the negative electrode is called the _____.

   d. The acid, which is not permanently changed in this experiment, can be considered to be a _____.

   e. This experiment proves that water is a (mixture, compound).

   f. Electrolysis is a (physical, chemical) process.

Title: LAB--Electrolysis of Water

PART THREE.....DECOMPOSITION OF WATER AND TESTING FOR THE ELEMENTS OF WHICH IT IS COMPOSED

1. Using tap water, refill the apparatus to the zero level. The stopcocks must be open. Close the stopcocks. Reconnect the power supply and allow the current to flow until the water level in both eudiometer tubes drops to at least 25 ml. Note: If the level of the liquids does not drop very soon after the application of electrical current, check your equipment for leakage. If you have any difficulty call your instructor. The level of the liquid indicates the amount of gas that has been collected. Disconnect the power. Record the volume of the gas in the anode tube and the cathode tube and record in your data sheet. It is expected that the student will determine before beginning the lab which electrode is the anode and which is the cathode.

2. Invert a test tube over the anode tube, open the stopcock, and allow the gas to escape into the test tube until the liquid level is again at zero. Quickly close the stopcock and place your thumb over the open end of the test tube. Insert a glowing splint into the test tube. Record your observations.

3. Repeat "Step 2" for the cathode, except use a burning splint for the test. Record your observations.

4. Related questions. (These questions are not to be answered during the laboratory period. They are included at this point in the lab procedures for the purpose of clarity and simplicity).

   a. The largest volume of gas produced is the element _____ _____.

   b. The mathematical ratio of the volume of the two gases produced is _____.

   c. At which electrode is the oxygen gas evolved? Can you determine any chemical reason why this should be true?

   d. At which electrode is the hydrogen gas evolved? Can you determine any chemical reason why this should be true?

   e. What happens to the sulfuric acid during the electrolysis? Study your text to see if you can determine why the acid is effective in aiding in the flow of electrical current.

   f. In the electrolysis of water large amounts of electrical energy are used. Can energy be destroyed? State the Law of Conservation of Mass and Energy. How does the Law of Conservation of Mass and Energy apply to this experiment?

Title: LAB--Electrolysis of Water

Clean Up. Thoroughly wash all laboratory equipment and glassware with a strong soap and water solution. All glassware must be thoroughly rinsed. Report any broken glassware or equipment to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the kind of condition that you would like to find it. Have consideration for your fellow classmates who must also use the laboratory. Special Note: Platinum electrodes are very delicate. Do not attempt to straighten the electrodes. Wash the electrodes as thoroughly as possible to remove all trace of acid and return the cleaned electrodes to your instructor.

Trade Relatedness:

1. Battery manufacturers today are labeling batteries as to their explosive nature. How can this phenomenon be explained in terms of the knowledge gained in this experiment?

2. Can electrolysis be used for the commercial production of hydrogen and oxygen on an economical basis? Explain.

3. The commercial production of chlorine, hydrogen gas, and sodium hydroxide is usually done by the electrolysis of brine in a device called a Hooker or Vorce cell. Explain how this is done. (Note: Consult your textbook for help).

4. The metallurgy of copper is somewhat complex. The first form of copper is called matte copper, the second form is blister copper, and the third form is about 99% pure copper. Explain how electrolysis is an important step in the production of pure copper.

Title: LAB--Electrolysis of Water

INSTRUCTOR'S NOTES

Due to the fact that the Hoffman apparatus is generally in limited supply, it is recommended that this lab be performed as a demonstration.

COMMENTS:

Title: LAB--Conductivity of Water Solutions

Unit: Water

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB. ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To develop knowledge of the types of materials in water solutions which have the ability to conduct electrical current.

Materials Required:

Solution conductivity apparatus; glacial acetic acid; ethyl alcohol; distilled water; tap water; sodium chloride crystals; potassium dichromate crystals; sodium hydroxide pellets; 5% solution of sucrose; 0.1 N solutions of the following - hydrochloric acid, sodium chloride, copper sulfate, ammonium hydroxide, potassium hydroxide, sodium hydroxide, acetic acid, nitric acid, sulfuring acid, saturated solution of calcium hydroxide.

Information:

Electrical current is the flow of electrons along a wire or possibly through a water solution such as the electrolyte in a battery. The voltage, or electrical pressure, is the force that moves the electrons through the conductor. Some materials, such as copper and silver, are very good conductors. Other materials, such as glass and porcelain, are very poor conductors. The conductivity of a material is based upon the number of electrical charges that are "free" to move through the material. Electrical charges may be simple electrons as in the case of a copper wire, or they may be complex ions.

Procedure:

PART ONE.....CONDUCTIVITY OF COMMON LABORATORY SUBSTANCES

1. Obtain a conductivity apparatus as illustrated on Page Two. Clean all connections and electrodes. CAUTION: IF 110 VOLTS ALTERNATING CURRENT IS TO BE USED IN THE LABORATORY, BE CERTAIN THAT ALL APPARATUS IS DISCONNECTED FROM THE POWER SOURCE BEFORE HANDLING OR CLEANING.

2. Test the conductivity of each substance listed in the table on Page Two. If the substance is a good conductor, the lamp will glow brightly. With fair conductors, the lamp will glow less brightly, with poor conductors, the lamp will glow dimly, and with very poor or nonconductors, the lamp will not glow at all. Place a check mark in the column which best describes the conductivity of each particular substance.

Title: LAB--Conductivity of Water Solutions

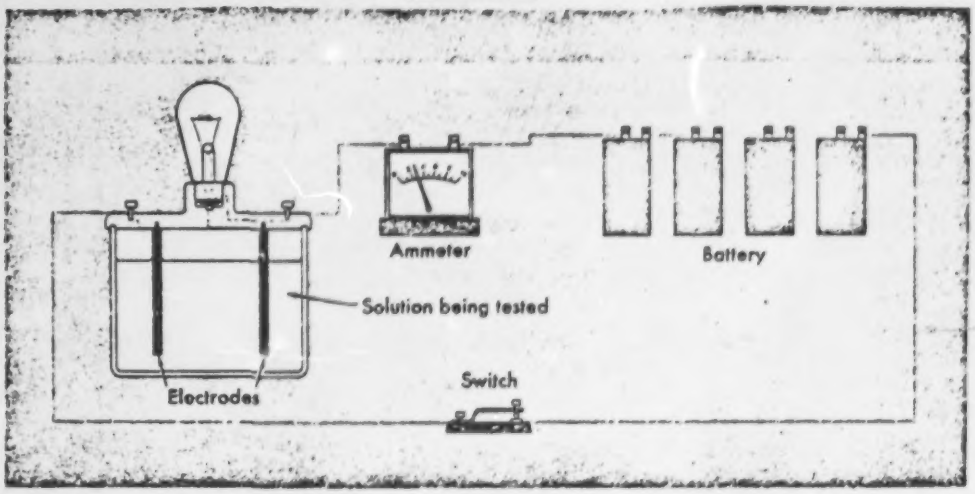


Figure 1. Electrical conductivity apparatus .

Substance tested	Conductivity			
	Good	Fair	Poor	Non-conductor
Sodium chloride (dry; fill beaker half full)				
Distilled water				
Tap water				
Sodium chloride solution (0.1 *N*)				
Copper sulfate solution (0.1 *N*)				
Ammonium hydroxide (0.1 *N*)				
Calcium hydroxide (saturated solution)				
Potassium hydroxide solution (0.1 *N*)				
Sodium hydroxide solution (0.1 *N*)				
Acetic acid (glacial)				
Acetic acid (0.1 *N*)				
Hydrochloric acid (0.1 *N*)				
Nitric acid (0.1 *N*)				
Sulfuric acid (0.1 *N*)				
Sugar (sucrose) solution (5%)				
Ethyl alcohol				

Title: LAB--Conductivity of Water Solutions

PART TWO.....CONDUCTIVITY OF MOLTEN SALTS AND BASES

1. Clean and dry the electrodes of the apparatus. Fill an evaporating dish about one-quarter full with dry potassium dichromate crystals. Lower the electrodes of the apparatus into the crystalline material. Turn on the electrical current. Record your observations in the data sheet.

2. Light a bunsen burner and heat the crystalline material until it melts. Record any changes in the conductivity of the material.

3. Repeat Steps 1 and 2 above using sodium hydroxide pellets. Record your observations.

Clean up. Thoroughly wash all laboratory equipment and glassware with a strong soap and water solution. Glassware must be well rinsed. Report any broken glassware or equipment to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the kind of condition that you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Conclusions:

1. What three classes of compounds are found to be electrolytes in this experiment?

2. A strong electrolyte is a good conductor in water solution; a weak electrolyte is a poor conductor. Classify the acids and bases tested in this experiment as strong or weak.

Strong		Weak	
Acids	Bases	Acids	Bases

Title: LAB--Conductivity of Water Solutions

3. Complete the following table of electrolytes and their ions in water solution.

Name	Formula	Ions	Name	Formula	Ions
Acetic Acid	NaCl	Na^+ Cl^-	Ammonium Hydroxide		
Hydrochloric Acid			Calcium Hydroxide		
Nitric Acid			Potassium Hydroxide		
Sulfuric Acid			Copper Sulfate		

Trade Relatedness:

Explain the theory of how the electrolyte in an automobile battery (sulfuric acid) conducts electricity.

Title: LAB--Purification of Water; Making Water Fit to Drink

Unit: Water

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To show some of the operations used in the treatment of a city water supply to make the water drinkable.

Materials Required:

Erlenmeyer flask; 250 ml. fitted with a number 6 solid cork stopper; test tubes; medicine dropper, graduated; powdered clay; fine sand; limewater; aluminum sulfate, $Al_2(SO_4)_3$, 5% solution; Ferrous sulfate, $FeSO_4$, (Iron II Sulfate), 5% solution; ammonium hydroxide, NH_4OH, dilute.

Information:

There are four stages in the treatment of the water to be used for drinking (a word which means drinkable is "potable") in a city: 1. Sedimentation (settling); 2. filtering; 3. coagulating; 4 purifying and adding chemicals. In the settling stage, the water coming into the system is collected in a large pond and made to stand quietly. The larger of the particles can settle to the bottom. In the filtering stage, the water is strained through large concrete containers, called beds, of gravel, sand, and charcoal. The water from most supplies could be drunk at this stage without harm, but we would not like it because of its cloudy appearance. The cloudiness is due to extremely small particles of matter floating in the water which cannot be filtered. Chemical reactions must be used to remove such small particles. In the coagulating stage, a reaction between chemicals causes a cloudy gel to form and fall to the bottom and as it does so, takes the small particles out with it. The final stage is purification by oxygen (seration), and chlorine, and the addition of a fluoride for the prevention of tooth decay.

Procedure:

PART ONE.....SEDIMENTATION (SETTLING)

1. Put a small portion of finely-powdered clay and a small portion of fine-grained sand into the 250 ml. Erlenmeyer flask. Fill the flask half full of tap water, stopper, and shake vigorously for several minutes. This will form an impure water sample.

Title: LAB--Purification of Water; Making Water Fit to Drink

2. Without setting the flask down, immediately fill one test tube full of the impure water sample. Allow the sample to stand quietly until you finish Procedure Two of the lab. With a strong light behind the test tube, examine the contents carefully. Describe your observations. Has the suspended matter settled partially or completely?

PART TWO.....SETTLING BY THE USE OF CHEMICAL REACTIONS: COAGULATION

1. Fill a large test tube half full with limewater. Using a medicine dropper, add the aluminum sulfate solution, drop by drop, until a white precipitate is formed. If a precipitate does not become readily visable, add a few drops of ammonium hydroxide to the test tube solution.

2. With a strong light behind the test tube, observe and describe the contents carefully. Allow the test tube to stand for a few minutes. Describe the results.

3. Repeat Sections 1 and 2 above using ferrous sulfate (Iron II sulfate) in place of the aluminum sulfate. Describe your observations.

4. Fill another test tube with the impure sample prepared in Procedure One. To the impure sample add 5 ml. of ammonium hydroxide and shake the solution thoroughly.

5. Add drop by drop, aluminum sulfate solution. Observe the reaction carefully. Describe what happens. Allow the test tube to stand undisturbed for several minutes. Describe the results.

Clean up. Thoroughly wash all laboratory equipment and glassware with a strong soap and water solution. All glassware must be thoroughly rinsed. Report any broken equipment and glassware to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the kind of condition that you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Trade Relatedness:

1. Explain how you can extend the useful life of cleaning solutions and paint brush cleaners by knowledge gained in this laboratory.

2. Visit a local water filtration plant and write a report on your trip. Include job opportunities which you may like.

Title: LAB--Purification of Water; Making Water Fit to Drink

3. How do rural and suburban water supplies from wells depend on the filtration action of the ground. What is the name of the test that is given ground to determine the filtering action?

Conclusions:

1. Why is city water allowed to stand in a quiet pool as the first step in purification?

2. What does the sticky precipitate remove from the water? What does the word precipitate mean?

3. When the proper amounts of aluminum sulfate and calcium hydroxide are added to water, why is it that the purified water does not contain the added chemicals in large amounts?

4. Why should sand filtration follow the step in the purification process where the coagulation chemicals are added.

Title: LAB--Hard Water and Water Softeners

Unit: Water

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To develop knowledge as to how hard waters are formed, the types of hard water, and how hard waters may be treated to produce soft water.

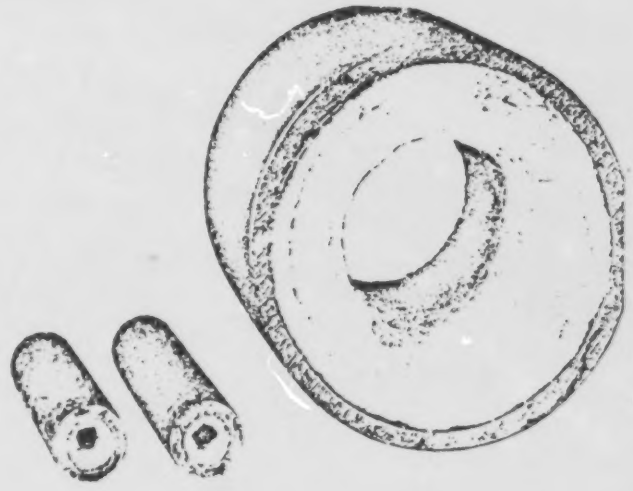
Materials Required:

Erlenmeyer Flask, 125 ml. (2); solid stoppers for 125 ml. flask; bunsen burner; ring stand; wire gauze; filter funnel; pipestem triangle; test tubes and solid stoppers to fit; watch glass, pyrex; graduated, 25 ml. carbon dioxide (Note: If carbon dioxide is not available in tanks, a CO_2 generator must be used); limewater; calcium sulfate, $CaSO_4$; distilled water; filter paper; magnesium sulfate, $MgSO_4$; soap solution, 1%; sodium carbonate, 0.4 N. solution.

Information:

Hard water is water in which certain minerals are dissolved. Hard water causes the buildup of a white crystalline material on the inside of boiler and heating pipes. Hard water prevents soap from building up suds and causes a ring to form around bathroom tub and basin. It causes a sticky stuff to form on clothes when being washed and is difficult to remove.

How does water become hard? Water is a very good solvent and as it falls through air with a high carbon dioxide content, as it flows over rocks and soil, a lot of minerals are absorbed. These dissolved minerals change soft water into hard water. The minerals with which we are mostly concerned in hard waters are the compounds of calcium and magnesium.



The scale of calcium carbonate which has collected on the inside of this pipe cuts down the flow of steam through it and acts as an insulator. Thus, the scale prevents efficient transfer of heat. (The Permutit Company)

Title: LAB--Hard Water and Water Softeners

PAGE TWO

(Consult a periodic chart and note the similarity of their respective positions).

Temporary hard water is formed from the bicarbonate of calcium or magnesium. Permanent hard water is formed from the sulfate of calcium and magnesium.

Procedure:

PART ONE.....THE FORMATION OF TEMPORARY AND PERMANENT HARD WATER

1. Temporary Hard Water

   a. Allow CO_2 to flow continuously through limewater. Carefully observe the result and record your observations.

   b. Allow the CO_2 to continue to flow through the limewater, carefully observe the result and record your observations.

2. Permanent Hard Water

   a. Obtain two 125 ml. Erlenmeyer flasks with solid stoppers to fit. Measure a small quantity of calcium sulfate into one flask, and add about 50 ml. of distilled water, stopper and shake well. Filter the solution to remove any undissolved matter. Dilute by adding 25 ml. of distilled water. Label the solution and save for a later procedure.

   b. Repeat "a" above with magnesium sulfate. Save the two solutions.

PART TWO.....HOW CAN YOU TELL THE DIFFERENCE BETWEEN HARD AND SOFT WATERS?

1. Fill three separate test tubes half full with distilled water, and each of the hard water solutions from 2a above. Add a few milliliters of soap solution to each test tube. Describe any change in the appearance of the solutions and record your observations in your data sheet.

2. Stopper the test tubes and shake for a few minutes. Describe the appearance of each of the test tubes.

PART THREE.....SOFTENING TEMPORARY AND PERMANENT HARD WATERS

1. Temporary Hard Water

   a. Place 25 ml. of temporary hard water in a beaker. Cover with a pyrex watch glass and heat to boiling. Boil the water slowly for four to five minutes. Describe any change in appearance you may see and record your observations.

Title: LAB--Hard Water and Water Softeners

b. Pour the boiled water from "a" above into a graduate and add enough distilled water to bring the volume back to 25 ml. Filter, label, and save the filtrate for later use.

c. After the beaker has air dried, examine the inside and describe its appearance. Record what you see.

d. Add 2 ml. of soap solution to about one-half of the filtrate from "b" above in a large test tube, stopper, and shake well. Describe the results in your data sheet.

2. Permanent Hard Waters

a. Obtain about 20 ml. of the calcium sulfate hard water solution from 2a (Part One) and determine if the water can be softened by boiling. (Follow the same procedure as above). Describe the result.

b. Pour 15 ml. of calcium sulfate hard water solution from 2a (Part One) into a 125 ml. Erlenmeyer flask. Add 5 ml. of 0.5N solution of sodium carbonate, stopper, and shake well. Record any change you may see.

c. Filter the solution into a clean 125 ml. Erlenmeyer flask. What is the name of the residue?_____. Add 2 ml. of soap solution to the filtrate and shake well. Describe the results in your data sheet.

Clean Up. Thoroughly wash all laboratory equipment and glassware in a strong soap and water solution. All glassware must be thoroughly rinsed. Report any broken glassware or equipment to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the kind of condition that you would like to find it. Have consideration for your fellow classmates who must also use the laboratory.

Trade Relatedness:

1. Describe boiler scale, what causes it, and what are its harmful effects in the home and industry.

2. What effect does hard water have on hair?

3. List the results of using hard water for laundering.

4. What effect does the use of hard water have on the general maintenance of porcelain items such as bathroom tile in shower stalls and grouting, bathtubs and basins?

Title: LAB--Hard Water and Water Softeners

5. What may be the effect of using hard water in the cooling system of engines.

6. Briefly explain how water softening systems for home and industry work.

Conclusions:

1. What effect may the use of hard water have on personal hygiene?

2. Describe the following terms: a) filtrate; b) residue.

3. Describe two methods that will soften temporary hard water but not permanent hard water.

4. Explain how all methods of water softening are alike in certain aspects.

METALS

Title: LAB--Extraction of Metals from Their Ores

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To show how metals can be recovered from the ore in which it is held.

Materials Required:

Ring stand; burrette clamp; small beaker; delivery tube; test tubes; laboratory burner; mortar and pestle; crucible, clay; copper oxide, powdered; wood charcoal; limewater; iron disulfate, FeS_2; copper sulfate, 0.5 N solution; iron nail; acetic acid.

Information:

To the technical student, a knowledge of metals is very important. Metallurgy is defined as the art and science of extractions of metals from their ores. This definition also includes the refining and purification of the reduced metal but excludes any form of making the metal into a useful product.

During the formation of the earth the extremely hot metallic elements readily gave up their outer electrons to such elements as oxygen and sulfur. This process is called oxidation. Man, in order to get usable metals back from the earth, must reverse the process of nature by finding a way to put electrons back into the metallic elements. This process is known as reduction. Therefore, the process of oxidation is the reverse of the process of reduction.

Procedure:

PART ONE.....HOW DOES THE RELATIVE CHEMICAL ACTIVITY OF METALS AFFECT THE REMOVAL OF METALS FROM SOLUTION?

1. Place 15 ml of 0.5 N copper sulfate solution in a test tube. Clean an iron nail with acetic acid and rinse well with water. Dry the nail. Carefully allow the nail to slide down the side of the test tube into the copper sulfate solution. Note: If a large nail is dropped into the solution, most likely a hole will be punched into the bottom of the test tube.

2. Set the test tube containing the copper sulfate and nail aside in a test tube rack until the end of the laboratory period.

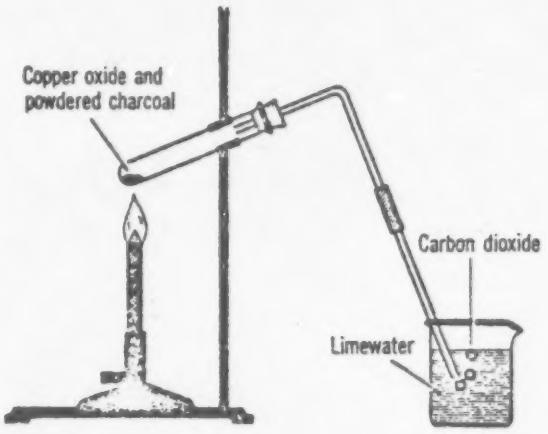
Title: LAB--Extraction of Metals from Their Ores

PAGE TWO

3. Examine the nail and the solution in the test tube at the end of the lab period. Describe the results of the test.

PART TWO.....HOW ARE METALS REMOVED FROM OXIDE-TYPE ORES?

1. Assemble the apparatus as shown in the figure at the right. Mix 10 grams of powdered copper oxide with an equal amount of powdered wood charcoal. Place the mixture in an ignition tube.



2. Heat the ignition tube gently at first, then strongly. Describe the results in your data sheet.

3. Continue heating strongly for about 10 minutes. Note: Some laboratory burner flame temperatures are high enough to melt the glass ignition tube. Do not allow this to happen. Describe the result in your data sheet.

4. Allow the ignition tube to cool then transfer the contents to a beaker. Allow a gentle stream of water to flow into the beaker to wash away the light weight material. Use a great deal of care. Examine the residue and describe the results in your data sheet.

PART THREE.....HOW ARE METALS REMOVED FROM SULFIDE-TYPE ORES?

1. Grind a few lumps of iron pyrite (iron disulfide, FeS_2) in a mortar. Place the iron disulfide in a clay crucible and heat gently at first, then strongly for about 15 minutes.

2. Describe the odor of the gas which is given off. Hold a strip of blue litmus paper, moistened in distilled water, in the gas and describe the result.

3. Let the crucible and the residue cool. Examine the residue and describe its appearance in your data sheet.

Clean Up: Thoroughly wash all laboratory equipment and apparatus with a strong soap and water solution. Glassware must be thoroughly rinsed. Report any broken equipment or glassware to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the same condition that you would like to find it. Have consideration for your fellow students who also must use the laboratory.

Trade Relatedness and Conclusions:

1. Coke is mixed with iron ore to produce iron and steel. Explain how this manufactured process takes place.

2. Waste water from the copper industry contains copper compounds in solution. Explain how these copper compounds may be recovered using scrap steel. How does this recovery process affect the environment and ecology?

3. Lead oxide mixed with charcoal and heated (reduced) produces what substances?

4. Lead sulfide heated in air gives off what gas and combines with _____ to produce what compound? How can the resultant compound be reduced?

5. Crude copper is refined by what process? List the three major steps of refining copper and the name given to the copper at each step.

Title: LAB--Relative Activity of Some Common Metals

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB. ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To show that some metals are more chemically active than others, and will take the place of other metals in solutions.

Materials Required:

Ring stand; iron ring; laboratory burner; beaker tongs; 3 - 100 ml beakers; test tube rack; test tubes; wire gauze; calcium; magnesium ribbon; aluminum foil; water; copper sulfate, 0.5 N solution; silver nitrate, 0.5 N solution; zinc sulfate, 0.5 N solution; zinc metal; copper metal; dilute hydrochloric acid.

Information:

The chemical activity of metals, and elements in general, depends upon the diameter of the atom and the number of valence electrons. Being that each metallic element differs in its atomic structure, the chemical activity of the elements also differs.

It would be helpful if you located each element on the periodic chart as you use it during the laboratory.

Procedure:

1. Relative activity of common elements.

   a. Set up a ring stand, iron ring, wire gauze, and laboratory burner and heat 100 ml of water to about 90°C. Using beaker tongs, pour about 15 ml of hot water into each of three 100 ml beakers.

   CAUTION: DO NOT HANDLE CALCIUM, OR OTHER ACTIVE METALS WITH BARE HANDS.

   b. Into each of the three beakers add samples of metallic elements as follows: Beaker 1, a small piece of calcium, Beaker 2, a piece of well cleaned magnesium ribbon about 4 cm. long; Beaker 3, a 4 cm. piece of well cleaned aluminum foil. Carefully look at the three beakers to detect any evidence of chemical reaction. Describe the results in the data sheet.

2. To show how one metal displaces another from solution.

Title: LAB--Relative Activity of Some Common Metals

a. Place four test tubes in a test tube rack, and label the test tubes 1 through 4. Pour 5 ml. of 0.5 N concentration of the solutions indicated in the table below, into the test tubes:

Test Tube Number	0.5 N Solution
1	Copper sulfate
2	Silver nitrate
3	Zinc sulfate
4	Silver nitrate

To test tubes 1 and 2, add a well cleaned strip of zinc metal. To test tubes 3 and 4, add a well cleaned strip of copper metal. Allow the test tubes to remain undisturbed until the end of the laboratory period.

b. At the end of the laboratory period, carefully observe each piece of metal and each of the solutions. Describe the results in your data sheet.

3. To compare the reactions of some metals with hydrochloric acid.

a. Place three test tubes in a test tube rack and pour about 5 to 10 ml. of dilute hydrochloric acid into each test tube. Label the test tubes 1 through 3.

b. To test tube one, add a 4 cm. length of well cleaned, tightly rolled magnesium ribbon; test tube 2, add a 4 cm. length of well cleaned, tightly rolled zinc metal; test tube 3, add a 4 cm. length of well cleaned, tightly rolled copper metal. The metal strips should all have approximately the same surface area.

c. Observe any reactions which may result and describe your observations in your data sheet.

Clean Up: Thoroughly wash all laboratory equipment and glassware in a strong soap and water solution. Glassware must be thoroughly rinsed. Report all accidents to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory in the same condition as you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Conclusions:

Title: LAB--Relative Activity of Some Common Metals

PAGE THREE

1. On the basis of the observations made during the lab, arrange the following elements in order from the most active to the least active: aluminum, calcium, magnesium.

2. On the basis of the observations made during the lab, arrange the following elements according to their reaction with hydrochloric acid from the most active to the least active: copper, magnesium, and zinc.

3. Make a table which will show which of the following metals will replace what other metals from solution: copper, silver, and zinc.

Title: LAB--Relative Activity of Some Common Metals

INSTRUCTOR'S NOTES

Reference can be made to LAB--Single Replacement Reactions

COMMENTS:

Title: LAB--Crystalline Structure of Metals

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To develop knowledge of the crystalline structure of metals.

Materials Required:

Beaker; general purpose tongs; safety goggles and apron; hand lens; 5 cm x 15 cm piece of galvanized steel; 5 cm x 15 cm piece of tin coated steel; 500 ml of 3.0 molar hydrochloric acid.

CAUTION: If you are to prepare the hydrochloric acid from concentrated 12 M reagent, ALWAYS POUR THE ACID INTO THE WATER (not vice versa). That is, always follow the alphabet: pour A cid T o W ater.

Information:

All metals in their solid form are crystalline in their structure. A crystal is a solidified particle in which all the atoms are arranged in a single geometric pattern. This pattern is known as a "crystal lattice". The pattern is repeated in all three directions.

Although the size of the atoms and molecules in crystals are too small to be seen readily in steel, the crystal arrangement can be verified by an x-ray spectrometer. However, we can obtain from tin, chemical symbol Sn, and zinc, chemical symbol Zn, an appreciation of the crystal structure of metals. Tin and zinc are used in this experiment because their crystals are large enough to be seen with the unaided eye.

Procedure:

1. Observing the crystals of tin.

   a. Wash a piece of tin coated steel thoroughly with a strong soap and water solution. Rinse to remove all soap, oils, and grease.

   b. Hold the prepared piece of tin coated steel with tongs and slowly lower it into the acid. Note: Depending upon the strength of the acid, some bubbling may occur. Leave the tin coated steel in the acid only a few seconds. Remove the metal sample and thoroughly rinse. Examine carefully for signs of crystals of tin. If nothing appears, repeat the etching process.

c. When the crystals become visible, rinse thoroughly and then draw a diagram showing your results.

2. Observing the crystals of zinc.

a. Zinc crystals are large enough that they do not have to be etched.

b. Examine the crystals of a piece of zinc coated steel and draw a diagram to show your findings.

Clean Up: Thoroughly wash all laboratory equipment and glassware with a strong soap and water solution. All glassware must be thoroughly rinsed. Report any broken equipment or glassware to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory in the same condition you would like to find it. Have consideration for your fellow classmates who also must use the laboratory.

Trade Relatedness and Conclusions:

1. Explain the process in industry called "pickling".

2. What effect does different crystal structures have upon the ability of metals to form an alloy.

3. How does the crystal lattice affect the properties of metals?

4. Describe briefly how crystals form in metals.

Title: LAB--Low Melting Point Alloys

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To study some metals and their characteristic changes when used to make an alloy.

Materials Required:

Ring stand; bunsen burner; crucible; clamps; beaker; water; samples of bismuth, lead, tin, and cadmium; thermometer (high scale), apron, eye shield.

Information:

Many metals when they are refined and processed for use, lack certain characteristics. In order to overcome any deficiency, other elements or metals are often added, thereby changing the original characteristics. Such an additional element or metal is called an alloying element, and the resulting metal is called an alloy.

In order to make plain steel stronger and harder, for example, carbon is added to produce carbon steel. To make stainless steel, nickel or chromium are added to carbon steel. To make a rust resistant steel, copper may be added. The addition of the alloying elements undoubtedly changes the characteristics of the resulting steel.

In some cases the physical properties are drastically changed. Two examples are WOODS METAL and ROSE'S METAL. Both are called low melting point alloys. The resulting metal alloy, in both cases, will melt at a temperature much lower than that of any metal which composes it.

The following are the melting points of some of the metals that comprise the above mentioned alloys:

Bismuth	271°C
Cadmium	321°C
Lead	327°C
Tin	232°C

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

Title: LAB--Low Melting Point Alloys

PAGE TWO

1. Measure out the proper quantities of each of the elements listed below, depending on which alloy the group is to observe:

WOODS METAL	ROSE'S METAL
2.0 gm bismuth	2.0 gm bismuth
1.0 gm lead	1.0 gm lead
0.5 gm tin	1.0 gm tin
0.5 gm cadmium	

2. Place each of the metals into a clay crucible and heat with a bunsen burner.

3. Stir to mix thoroughly and measure the temperature of the melted combination of metals. BE CERTAIN TO USE THE PROPER THERMOMETER (HIGH SCALE). The temperature of the melted metals is _____ °C.

4. After all the metals have been melted and mixed, pour carefully into a mold or onto a plate. Allow to cool and harden.

5. Prepare a beaker with water and place the SOLID alloy into the beaker.

6. Place a thermometer in the beaker (USE PROPER THERMOMETER) and heat the contents of the beaker with a bunsen burner.

7. As the water is being heated, observe the reaction of the alloy. At what temperature did the alloy begin to melt?

   _____.

   At what temperature was the alloy completely melted?

   _____.

8. How does the temperature compare to the temperatures (melting points) of the constituent elements?

9. Carefully pour off the water in the beaker and allow the alloy to solidify. Examine the alloy. How does it compare, in appearance, with the original constituent elements?

10. What are some uses for these low melting point alloys?

11. Write a formal lab report according to the proper format.

CLEAN YOUR WORK STATION. BE CERTAIN THAT EVERYTHING IS IN ITS PROPER LOCATION. INSTRUCTOR'S INITIALS_____.

Title: LAB--Thermit Process

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To show how aluminum powder is used as a reducing agent to produce hot iron for welding.

Materials Required:

Ring stand; clamps; asbestos board; iron pan; filter paper; thermite mixture; starting mixture; magnesium ribbon; sand; bunsen burner; asbestos mat; fire extinguisher; copper sample; tongs; apron, eye shield.

Information:

Small pieces of iron and steel may be welded by means of welding rods melted with an oxy-acetylene torch. Larger articles must be welded by means of an electric-weld process. Much larger articles, such as steel beams and rails, must be welded by the thermite process. In this process, aluminum powder (acting as a reducing agent) produces an extremely hot iron from ferric oxide.

A reduction reaction refers to any process in which an electron is ADDED to an atom or ion (in an oxidation reaction, the electron is lost). Materials such as hydrogen, carbon, carbon monoxide, aluminum, etc. have a greater desire for oxygen than other metals. Therefore, these materials can be used to remove oxygen from their compounds.

Some examples of reactions (reduction reactions) are

(A) extracting iron (in a blast furnace)
$2FeO + C \rightarrow 2\ Fe + CO_2\uparrow$ or $FeO + CO \rightarrow Fe + CO_2\uparrow$

(B) extracting zinc
$2\ ZnO + C \rightarrow 2\ Zn + CO_2$

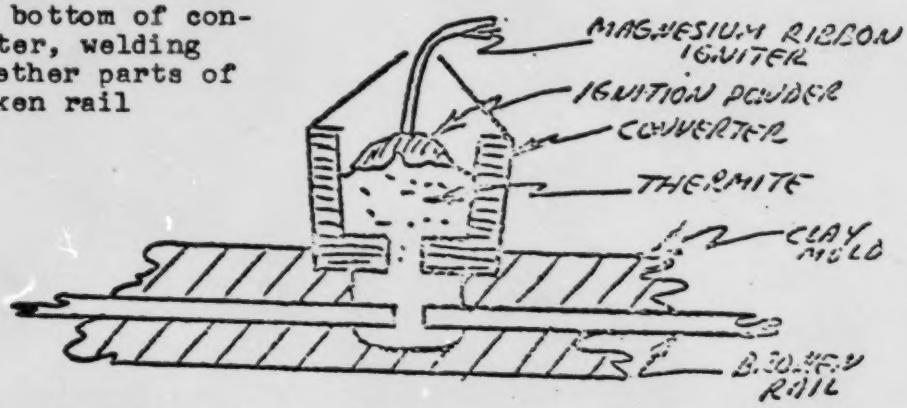
(C) extracting chromium
$CrO + H2 \rightarrow Cr + H2O\uparrow$ (vapor) or $CrO + Al \rightarrow Cr + Al2O3\uparrow$ (Vapor)

(D) thermite welding
$2Al + Fe_2O_3 \rightarrow 2\ Fe + Al_2O_3$

Title: LAB--Thermit Process

The reaction in (D) occurs when coarsely powdered iron oxide and aluminum (this mixture is called thermit or thermite) are mixed and ignited by means of a magnesium fuse imbedded in barium peroxide (used as a starter). Often, magnesium powder or potassium chloride are also used as a starter.

THERMITE WELDING--- molten iron flows out bottom of converter, welding together parts of broken rail



Procedure:

THIS IS A GROUP LAB. FOR SAFETY REASONS IT WILL BE PERFORMED BY THE INSTRUCTOR AS A DEMONSTRATION. NOTES ARE TO BE TAKEN BY THE STUDENT, AND OBSERVATIONS WILL BE MADE AND DATA RECORDED.

The apparatus will be set up as illustrated below:

Title: LAB--Thermit Process

DO NOT LOOK DIRECTLY AT THE APPARATUS WHEN THE REACTION BEGINS. THE LIGHT EMITTED IS VERY BRIGHT.

STAY BACK FROM THE APPARATUS AS SPARKS MAY SHOWER AS THE REACTION OCCURS, AND INTENSE HEAT WILL BE DEVELOPED.

When the thermite was ignited, what was observed?

After it has cooled, examine the material that has fallen into the sand and describe it. Test it to see if it is a ferrous material.

What is the approximate temperature of the reaction? What proof do you have?

How much heat is liberated in this reaction?

In this process, what was the reducing agent?

WRITE A LAB REPORT ACCORDING TO THE PROPER FORMAL LAB FORMAT.

197 200

THE ALUMINOTHERMIC PROCESS—A VARIATION

A Chem Ed TESTED DEMONSTRATION

Submitted by: Charles Chakoumakos, Wantagh High School, Wantagh, New York
Checked by: Daniel O. Smith, Northwest High School, Jackson, Michigan

PREPARATION

Assemble the apparatus shown at the right. The crucible, which acts as the reaction vessel, is provided with a $\frac{1}{8}$-in. orifice in the bottom. The Vycor crucible, tripod, and gallon can are centered directly below this hole.

DEMONSTRATION (parken Room - more dynamic)

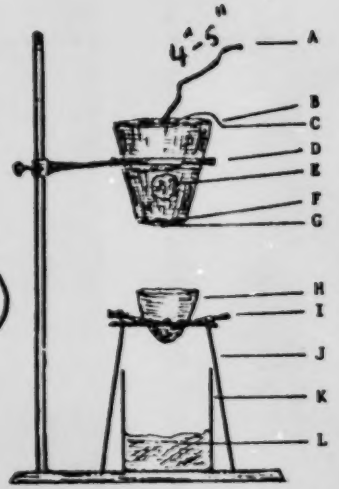
The magnesium strip is firmly entrenched in the mixture and ignited with a Bunsen flame. The usual display of this energetic reaction is evident. The customary safety precautions against flying sparks are necessary. (stand 8-10' away)
Wear Have a fire extinguisher available

REMARKS

The Vycor crucible cracks only on cooling. The slag and iron are solid by then, and the relationship of slag over iron is clear. Quenching in cold water will remove the Vycor glass for a closer study of the slag and iron. The heat resistance of Vycor becomes obvious. The gallon can with sand is a safety precaution.

EDITOR'S NOTE

For an alternate and perhaps more dependable ignition procedure, see ALYEA, "Tested Demonstrations in General Chemistry," 7-3, JOURNAL OF CHEMICAL EDUCATION, Easton, Pennsylvania.



A, Magnesium ribbon; *B*, sand crucible, 100 ml; *C*, starting mixture; *D*, ring; *E*, thermite; *F*, paper cover; *G*, hole; *H*, Vycor crucible, 30 ml; *I*, pipe stem triangle; *J*, tripod; *K*, gallon can; *L*, sand or dirt

(1 Teaspoonful)
Thermite Mixture - (3 parts Fe_2O_3 + 1 part Al powder) $KClO_3$ - starter ¼ Teaspoonful

Title: LAB--Thermit Process

INSTRUCTOR'S NOTES

Copper sample is placed in mixture prior to ignition. Its melting helps approximate the temperature of the reaction. Other metals can be substituted.

Darkening the room makes the demonstration more dynamic.

A container of water can be placed below the cone. Its boiling away often adds to the effect.

COMMENTS:

Title: LAB--Annealing and Hardening of Steel

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To show some of the methods used to give steel some of its special properties.

Materials Required:

Laboratory burner; tongs, general purpose; file; large size sewing needles; wire; soft iron; #16 AWG; safety razor blades; emery cloth; oil, SAE 30 or higher.

Information:

Annealing is a process of heating a metal to a high temperature then allowing it to cool very slowly. It is used to eliminate the effects of cold-working, to remove internal stress, and to improve special characteristics of steel.

Hardening steel is accomplished by heating steel to a high temperature then cooling it very rapidly by submerging it in any of several liquids such as water or oil.

Procedure:

1. Annealing of steel.

   a. Try bending a steel sewing needle (not a common pin). Then attempt to bend a piece of soft iron wire and a small iron nail. Describe your results.

   b. Try cutting a steel sewing needle with a file. Then try the piece of soft iron wire. Describe your results.

   c. Heat a needle in a burner flame until it glows with red heat. Slowly raise the needle above the flame in such a way as to reduce the temperature of the metal continuously until it is cool enough to be touched with your fingers. This takes patience. Try bending and cutting the needle as above. Describe your results.

2. Hardening

   a. Heat another needle to redness and quickly plunge it into a beaker of cold water. Try bending it and cutting it with a file. Describe your results.

b. Using a piece of soft iron wire, repeat Step a. Describe your results.

c. Using another piece of soft iron wire, heat the wire in a burner flame until it flows with red heat, then plunge it quickly into a beaker of oil. Describe the result. Compare the result with that of quenching with water.

d. Using an old safety razor blade, repeat Steps b and c. Describe your results.

Clean Up: Thoroughly wash all laboratory equipment and glassware in a strong soap and water solution. Glassware must be thoroughly rinsed. Report any broken equipment or glassware to your instructor. Remember: A place for everything - everything in its place. Leave the laboratory area in the same condition that you would like to find it. Have consideration for your fellow classmates who must also use the laboratory.

Trade Relatedness:

1. What is meant by heat treatment?
2. What is meant by critical or transformation range? Why is it important?
3. What is annealing? What effect does it have on the metal? Why?
4. How is steel hardened?
5. How does quenching affect: a) hardness, b) tensile strength, c) ductility, d) brittleness?
6. Why are tools quenched? Why are axles quenched?
7. Why is it necessary to cool steels very rapidly in order to harden them?
8. What is the advantage of an oil quench over a water quench?

Title: LAB--Tensile Testing

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To study various tensile specimens and determine their ultimate strength, yield point and ductility.

Materials Required:

Dillon tensile tester; various test specimens; micrometer; ruler or scale; scriber or gage length marker; apron; eyeshield.

Information:

The tensile test is carried out in a variety of machines, all of which have these common points: a means for straining (stretching) the speciman and a device for measuring the load being applied.

In our test, a speciman is loaded to failure between the grips of a Dillon testing machine. The properties most commonly determined are: yield point, tensile or ultimate strength, elongation and reduction in area.

As the speciman is subjected to an ever-increasing load, it continues to elongate until rupture. The elongation is neither proportional to the load nor permanent throughout the test. In the beginning, elongation is proportional but not permanent. If the load were removed or released, the speciman would return to its original length. In effect the speciman was loaded within its elastic limit. As the load continues to increase, the speciman will reach a point at which the elastic or temporary deformation ends and a plastic or permanent deformation begins. This is known as the elastic limit.

The speciman takes on a permanent set as the load continues to increase. When this permanent deformation is reached, the yield point is reached. From this point on, there occurs a marked increase in strain without an appreciable increase in stress (generally, there is an increase in deformation or elongation without a further increase in load). Any further increase in load causes the metal to "neck down" and rupture occurs.

A measure of ductility is the percentage reduction of the cross-section area at the rupture and the percentage increase of the original gage length. The gage length is the length marked off on the reduced portion of the speciman before application of the load and is usually one or two inches. In reporting, gage length must be specified to determine elongation.

Title: Lab--Tensile Testing

PAGE TWO

The following are the commonly used formulas:

$$\text{CROSS SECTION AREA} = \text{width} \times \text{thickness}$$

$$\text{ULTIMATE STRENGTH} = \frac{\text{ultimate load}}{\text{original cross-section area}}$$

$$\%\ \text{ELONGATION} = \frac{\text{distance between marks after break} - \text{gage length}}{\text{original cross-section area}} \times 100$$

$$\%\ \text{REDUCTION OF AREA} = \frac{\text{Original cross-section area} - \text{break area}}{\text{original cross-section area}} \times 100$$

Procedure:

THIS LAB WILL BE DEMONSTRATED BY THE INSTRUCTOR WITH STUDENT ASSISTANCE. ALL OBSERVATIONS SHOULD BE NOTED AND RECORDED.

1. Obtain tensile speciman. Measure and record width and thickness of the reduced section.
2. Mark off gage length on the reduced section. Be careful not to scratch or injure the reduced section of the speciman or it may fail prematurely--these injuries to the reduced portions are called "stress raisers".
3. Place speciman in tensile tester, locking upper jaws first, then the lower jaws.
4. Zero dynamometer by manipulating the control in the center of dynamometer and then turning zeroing indicator clockwise to the left of zero.
5. Apply load in tensile direction and record yield and ultimate loads.
6. After rupture, remove broken pieces and measure and record the width and thickness at the break. Then place the broken pieces together and measure and record the distance between the gage marks (this distance minus the gage distance gives the elongation).
7. Repeat the above steps for all the test specimens.
8. Compute all the necessary information. Write a lab report according to the proper format.

Title: LAB--Rockwell Hardness Testing

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To use the Rockwell hardness tester and to determine the hardness of various metal samples.

Materials Required:

Rockwell hardness tester (complete with test blocks, brale and ball penetrators and various anvils); belt sander; various metal samples; apron; eyeshield.

Information:

Hardness is the property of a metal which gives it the ability to resist being permanently deformed when a load is applied. The greater the hardness, the greater the resistance to deformation. Since the definitions for ultimate strength and hardness are somewhat synonymous, in general it can be assumed that a strong metal is also hard.

One way to measure the hardness of a metal is to determine its resistance to the penetration of a nondeformable ball or cone, or to determine the depth to which such a ball or cone will sink into the metal under a given load. The Rockwell hardness tester is widely used for testing hardness. It measures the resistance to penetration. The depth of the impression is measured and the hardness is indicated directly on the scale attached to the machine. This scale is really a depth gage graduated in special units. The value of the Rockwell units depends upon the depth of impression that is made on the surface of the sample and the force of penetration under certain combinations of penetrator and load. The two most commonly used ranges on the dial of the tester are the Rockwell C and the Rockwell B scales.

In testing soft metals, a 1/16 inch steel ball penetrator with a 100-kilogram load is used. The hardness is read on the B scale (red) of the dial. For testing hard materials, a diamond cone (known as a brale) is used with a 150-kilogram load. The hardness is read on the C scale (black) of the dial. The penetrators are held in a chuck. The specimens are placed on an anvil (the type of anvil depends on the shape of the sample).

The advantages of the Rockwell tester are that

A) the test can be made quickly
B) only a small mark is left on the sample
C) very hard materials can be tested with the diamond cone.

Title: LAB--Rockwell Hardness Testing

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Obtain metal sample to be tested from your instructor. If necessary, remove burrs from sample on the belt sander.

2. Check the crank handle of the Rockwell hardness tester and return it to the upward position before starting the test.

3. Select the penetrator and anvil to suit the sample tested. The penetrator and anvil selected are:

4. Select the scale and major load: They are:

5. Place sample securely on the anvil. Elevate sample until it contacts the penetrator. Continue elevating until small pointer on the dial is nearly vertical and the large pointer is vertical.

6. Turn zero adjuster until the SET arrow on dial is exactly in line with the large pointer.

7. Press down depressor bar to apply major load and watch pointer until it stops.

8. Pull crank handle upward slowly, lifting major load, but leaving minor load still applied.

9. Read Rockwell hardness on proper scale of the dial. The hardness is:

10. Take two more hardness readings on one side of the sample, following the above directions each time. Record the readings in each case. Have your instructor check you going through one of the readings. INSTRUCTOR'S INITIALS_____.

11. List the three readings here _____ _____ _____. Calculate the mathematical average of these three readings. The average hardness is _____.

12. Your instructor will give you the hardness data for other samples tested by others in your class. Prepare a lab report according to the proper format. Include a bar graph to show the comparisons in hardness of all the samples tested.

BE CERTAIN THAT EVERYTHING IS IN ORDER. RETURN ALL MATERIALS AND EQUIPMENT TO THEIR PROPER LOCATION. INSTRUCTOR'S INITIALS_____.

Title: LAB--The Recovery of Scrap Aluminum

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To recover wasted aluminum and convert it into alum.

Materials Required:

Aluminum foil (or scrap aluminum beverage or food can); shears; funnel; 2 pieces filter paper; 2 250-ml. beakers; stirring rod; bunsen burner; striker; triple beam balance; ring stand; ring; wire gauze; 100-ml. graduated cylinder; paper towel; apron; eyeshield; water; sodium hydroxide solution; sulfuric acid solution; potassium hydroxide solution; alcohol (ethanol).

Information:

Aluminum foil is an important and useful household item. Tons of aluminum metal in this form are produced annually. The foil is used for wrapping foods for storage, cooking, etc. Eventually it is thrown out and it finds its way to the garbage dump where it disappears from view. Aluminum is also used to produce cans for soda, juices, beer, and so on. These items, too, eventually end up in the dump. The end result in any case is ecologically undesirable. Aluminum is chemically quite inactive and will not readily break-down and enter the natural cycle.

In this lab, you will observe how a material usually wasted can be converted into something useful. In particular, the discarded and, therefore, worthless aluminum will be converted into alum.

Alums belong to a group of compounds that are called DOUBLE SALTS because the ions present in a water solution are the ions of the two salts that constitute the molecule. In this lab, alum is a hydrated double sulfate of potassium and aluminum, $KAl(SO_4)_2 \cdot 12H_2O$. It is used extensively in such industries as the manufacture of dyes, paper, glue and cement. It is also used in tanning and water purification. It has important medical and dental applications as well. Conversion of waste aluminum into alum is a good example of the ways in which materials may be "recovered".

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

1. Place 1 gram of shredded aluminum foil or scrap aluminum from a can into a 250 ml. beaker.

20809

Title: LAB--The Recovery of Scrap Aluminum

PAGE TWO

2. To the contents of the beaker carefully add 25 ml. of water and 25 ml. of 10% NaOH (sodium hydroxide) solution. The reaction will at first be slow, but will accelerate as the metal goes into solution.

$$2Al + 6NaOH \rightarrow 3H_2 + 2Na_3AlO_3$$

3. When the reaction is over, add 50 ml. of water to the contents of the beaker and filter into a second 250-ml. beaker.

4. Clean the first beaker. Discard the filter paper and the collected impurities in the proper location.

5. CAREFULLY add the sulfuric acid solution to the contents of the second beaker. While pouring SLOWLY, stir until the solution is acidic (about 20 ml of the acid solution will be needed). You should observe a precipitate forming. The precipitate is hydrated aluminum oxide, $Al_2O_3.3H_2O$, often called aluminum hydroxide $Al(OH)_3$.

$$2Na_3AlO_3 + 3H_2SO_4 \rightarrow 2Al(OH)_3\downarrow + 3Na_2SO_4$$

6. Dilute, with water, the contents of the beaker. Filter into the clean beaker. SAVE THE FILTRATE.

7. Clean the empty beaker. Scrape the precipitate from the filter paper and place it in the clean beaker.

8. CAREFULLY add 40 ml. of the sulfuric acid solution to this beaker.

9. Set up the ring stand and bunsen burner. CAREFULLY heat this beaker and its contents until a CLEAR solution of aluminum sulfate is obtained.

$$2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$$

10. To this clear solution, CAREFULLY add 20 ml. of KOH (potassium hydroxide) solution. Boil down to a volume of about 25 ml. and permit to cool to room temperature.

11. About 10 gm of salt-like crystals of alum should be obtained. Their isometric octahedral structure will be apparent (slight amgnification will emphasize this). Scrape the crystals onto the paper towel. Rinse with alcohol. Permit to dry.

CLEAN UP YOUR WORK STATION. BE CERTAIN THAT EVERYTHING IS IN ITS PROPER PLACE. INSTRUCTOR'S INITIALS_____.

Title: Lab--The Recovery of Scarp Aluminum

INSTRUCTOR'S NOTES

Preparing the solutions:

10% sodium hydroxide --
111 gm NaOH/ liter H_2O

Sulfuric acid--
10 ml. conc. H_2SO_4 and 90 ml. H_2O

Potassium hydroxide--
3 gm KOH and 25 ml. H_2O

An alternative to boiling the solution down, as indicated in Step 10, is to permit the uncovered beaker to stand for several days. Spectacularly large alum crystals will be obtained.

COMMENTS:

Title: LAB--Chemical Reactions with Copper

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe chemical reactions and write chemical equations.

Materials Required:

Metallic copper (wire, turnings or sheet scraps); concentrated nitric acid, silute sulfuric acid, sodium hydroxide solution; water; zinc metal; red litmus paper; 2 250-ml. beakers; 100 ml. graduated cylinder; triple beam balance; watch glass; ring stand; 2 rings; wire gauze; funnel; filter paper; bunsen burner; striker; stirring rod; evaporating dish; asbestos gloves or mitts; apron; eye shield.

Information:

This lab consists of a series of chemical reactions involving copper. You will start with metallic copper, Cu, and combine it with other elements to yield copper compounds--$Cu(NO_3)_2$. $Cu(OH)_2$, CuO, and $CuSO_4$.

Finally, at the end of this lab, you will isolate the copper as metallic copper again.

You will be required to write the various chemical equations for the reactions observed. Remember the following:

1. Translate the words into chemical symbols.
2. Consider the diatomics.
3. Balance any formulas by checking valences and using subscripts.
4. Balance the entire equation by using coefficients.
5. Indicate gases and precipitates.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. DO YOUR OWN WORK. KEEP YOUR WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES. REMEMBER TO HANDLE ALL SOLUTIONS CAREFULLY. AVOID ANY SPLASHING OR SPILLING. SHOULD A SPLASH OR SPILL OCCUR, PURGE THE AREA THOROUGHLY WITH WATER (OR USE A NEUTRALIZER GIVEN TO YOU BY YOUR INSTRUCTOR).

1. Weigh about 2 grams of metallic copper. The actual weight of the copper is _____.

2. Place the copper into a 250 ml. beaker and take the beaker and its contents to the hood area.

3. UNDER THE HOOD, CAREFULLY add 10 ml. of concentrated nitric acid. REMEMBER TO HANDLE ALL SOLUTIONS CAREFULLY AND TO AVOID SPLASHING AND SPILLING.

4. Cover the beaker with a watch glass and allow to stand UNDER THE HOOD until all the copper dissolves.
INSTRUCTOR'S INITIALS_____.

5. Carefully remove the watch glass and ALLOW THE FUMES TO DISAPPEAR.

6. CAREFULLY take the beaker and its contents back to your work station.

EQUATION A -- The metallic copper reacted with nitric acid to yield copper (II) nitrate plus hydrogen gas.

7. CAREFULLY AND SLOWLY add 20 ml. of sodium hydroxide solution to the contents of the beaker. REMEMBER TO HANDLE THIS SOLUTION WITH CARE.

8. Test the solution with red litmus paper. If the red litmus turns blue, proceed to the next step. If the litmus paper remains red, continue to CAREFULLY add the sodium hydroxide solution until the contents changes to a blue color. A precipitate will appear.

EQUATION B -- The copper (II) nitrate reacted with sodium hydroxide to yield copper (II) hydroxide (a precipitate) and sodium nitrate.

9. Set up ring stand and bunsen burner for heating and filtering operations. Place a clean 250 ml. beaker under the funnel to catch the filtrate. INSTRUCTOR'S INITIALS_____.

10. Add 100 ml. water to the contents of the original beaker.

11. CAREFULLY AND GENTLY boil the contents of this beaker with CONSTANT STIRRING until the blue color disappears or darkens.

EQUATION C -- The heat breaks down the copper (II) hydroxide to yield copper (II) oxide and hydrogen gas. Copper (II) oxide is a precipitate.

12. CAREFULLY filter the contents of the original beaker into the clean beaker. REMEMBER, THE BEAKER MAY STILL BE HOT. USE ASBESTOS GLOVES OR ALLOW TO COOL BEFORE HANDLING. Wash all solids, with some water, from the original beaker into the filter. Discard the filtrate. DO NOT DISCARD THE RESIDUE ON THE FILTER PAPER.

13. Wash the solid in the filter (the residue) several times with water. Discard the water after you have washed the solid. Clean both beakers.

14. Place a clean beaker under the funnel of the filtering apparatus. With the stirring rod, carefully punch a hole in the apex of the filter paper.

15. CAREFULLY pour 20 ml. of dilute sulfuric acid through the filter, catching it in the beaker. REMEMBER THE SAFE HANDLING OF SOLUTIONS. Pour the SAME solution back through the filter, catching it in a beaker as before. Repeat this process until all the solid has dissolved.

16. Wash the filter paper with a small amount of water and combine all the solutions. Discard the filter paper.
INSTRUCTOR'S INITIALS_____.

EQUATION D -- The copper (II) oxide reacted with the sulfuric acid to yield copper (II) sulfate plus water.

17. Add 1 gram of zinc metal for each gram of copper used in Step 1 to the solution in the beaker.

18. Stir occasionally UNTIL THE SOLUTION BECOMES COLORLESS. Copper metal will precipitate.

EQUATION E -- The copper (II) sulfate reacts with the zinc to yield copper (a precipitate) and zinc sulfate.

19. CAREFULLY add 10 ml. of water and 5 ml. dilute sulfuric acid to dissolve any excess zinc in the beaker.

20. Stir contents of beaker. Allow copper to settle. Pour off (decant) the water solution only. DO NOT POUR OUT THE SOLID.

EQUATION F -- The sulfuric acid reacted with any excess zinc to yield zinc sulfate and hydrogen gas.

21. Add 50 ml. of water to the beaker. Stir. Carefully pour off the water. Repeat this step a second time.
INSTRUCTOR'S INITIALS_____.

EQUATION G -- The copper is washed to remove the excess acid. Copper plus water yields copper plus water.

22. Weigh the evaporating dish. Weight of dish is _____.

23. Transfer the copper from the beaker to the evaporating dish. Remove any excess zinc.

24. Heat the evaporating dish to remove any water. ALLOW TO COOL.

25. Weigh the evaporating dish and copper. Weight is _____. The weight of the copper alone is _____. The percentage recovery of metallic copper is _____%.

26. Write all the equations on the work sheet and turn in to your instructor.

CLEAN YOUR WORK STATION. REPLACE ALL MATERIALS AS DIRECTED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____.

Title: LAB--Chemical Reactions with Copper

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WORK SHEET

EQUATION A --

EQUATION B --

EQUATION C --

EQUATION D --

EQUATION E --

EQUATION F --

EQUATION G --

Percentage recovery of copper was _____

List any problems you encountered in this lab --

Title: LAB--Electroplating

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To become acquainted with the method of electroplating.

Materials Required:

2 copper strips (3 cm x 10 cm); copper sulfate solution; water; alcohol; 3 250-ml. beakers; low-voltage DC source (12 volt battery or other supply); DC ammeter (0 to 3 amp range); rheostat (20 to 40 ohms); insulated wire and leads with alligator clips; knife switch; triple beam balance; fine sandpaper; meter stick (or other measuring device); magnifying glass; apron, eye shield.

Information:

An ordinary atom of any element is electrically neutral since it contains an equal number of elementary negative and positive electrical charges. A single electron carries an elementary negative charge, while a proton carries the elementary positive charge. The charge on the proton, therefore, exactly neutralizes the charge on the electron.

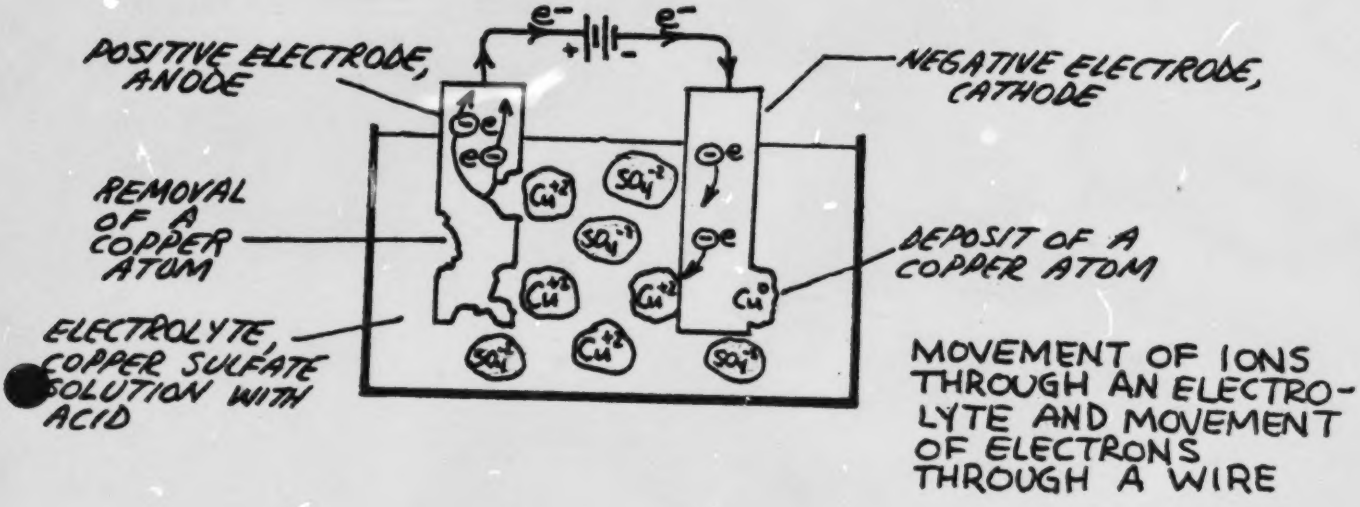
An atom becomes a positive ion having a charge equal to the elementary positive charge when it loses a single electron. Should the atom lose two electrons, it becomes a positive ion having an ionic charge equal to two elementary positive charges.

Assume two copper electrodes, connected to a battery, are inserted in a solution of copper sulfate (the solution also contains some sulfuric acid). This conducting solution is called the electrolyte, and it contains positive copper ions and negative sulfate ions. The cathode, or negative electrode, attracts the positive copper ions. Each positive copper ion picks up two negative electrons from the cathode to become an uncharged copper atom. The uncharged atoms are deposited on the cathode as metallic copper.

At the same instant at the anode, or positive electrode, each copper atom is stripped of two electrons by the energy of the battery. The atom becomes a positive copper ion. The copper ion enters the solution to replenish the supply of copper ions in the electrolyte. The supply of positive copper ions in the electrolyte, therefore, remains essentially constant. The electrons given up by the copper atom to the anode are transferred by the action of the battery to the cathode through the connecting wires. This

maintains the supply of free electrons at the cathode for changing positive copper ions into neutral copper atoms.

Keep in mind, then, that A) for every copper atom removed from the anode, one copper atom is deposited on the cathode; and B) the total number of positive charges that move from the cathode to the anode in the electrolyte in a given time is equal to the number of electrons that pass through the battery wires in the same time interval.

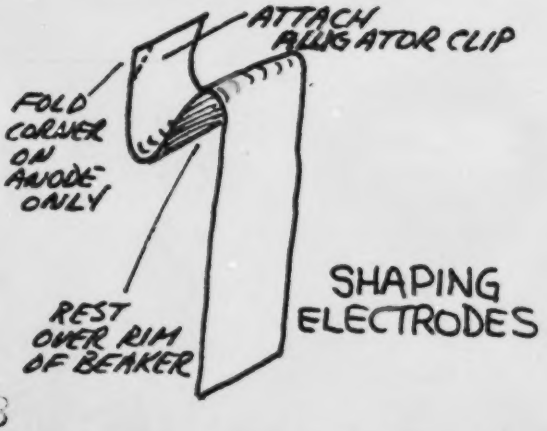

POSITIVE ELECTRODE, ANODE
NEGATIVE ELECTRODE, CATHODE
REMOVAL OF A COPPER ATOM
DEPOSIT OF A COPPER ATOM
ELECTROLYTE, COPPER SULFATE SOLUTION WITH ACID
MOVEMENT OF IONS THROUGH AN ELECTROLYTE AND MOVEMENT OF ELECTRONS THROUGH A WIRE

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. DO YOUR OWN WORK. KEEP YOUR WORK AREA CLEAN. HANDLE ALL SOLUTIONS CAREFULLY. BE CAREFUL WITH ELECTRIC CIRCUITS. PRACTICE SAFETY AT ALL TIMES.

1. Get two 250 ml. beakers. Fill one about two-thirds with water. Fill the second about two-thirds with alcohol. Put the beakers aside. They will be used later in cleaning the electrodes.

2. Get two copper strips. Bend one end of each strip into an S-shape to permit it to rest over the edge of the beaker and permit attachment of an alligator clip (refer to diagram). Use a clean empty 250 ml. beaker to help judge an appropriate bend. Fold one corner over on ONE STRIP ONLY (on the end the bend was made).



This strip will be the ANODE. The strip without the folded corner will be the CATHODE.

3. Take the empty beaker and assume that it will later be filled to two-thirds capacity. With a ballpoint pen or other marker, make a mark to indicate the level to which it will be filled.

4. Place the electrode that is the CATHODE in position in the empty beaker. Determine the portion of the electrode that will be submerged using the fluid level mark from Step 3 as a guide. Calculate the area of the cathode that is submerged (remember that it has a rectangular shape). Since both sides of the cathode will accept copper ions, multiply this area by 2. The total submerged area is _____.

5. Rub the portions of both electrodes to be submerged with fine sandpaper. They should be uniformly bright and shiny. DO NOT TOUCH THE CLEANED ELECTRODES WITH YOUR FINGERS.

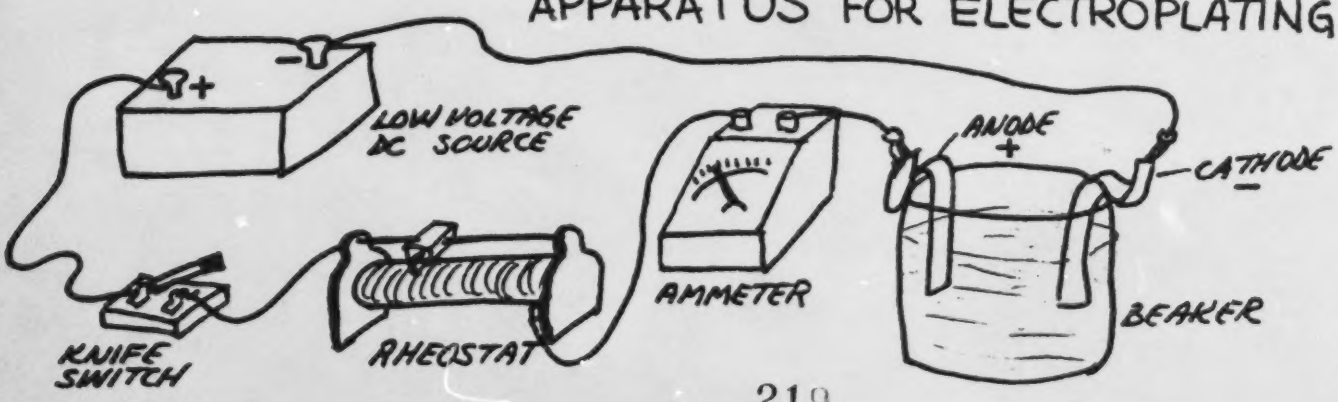
6. Carefully examine the electrodes with the magnifying glass. How do they appear? Describe their appearance.

7. Rinse the electrodes in running water and place them in position in the empty beaker. Remember that the ANODE HAS THE FOLDED CORNER.

8. About 0.02 amperes of current should be provided for each square centimeter of area to be plated. Multiply this value by the area calculated in Step 4. Your answer will be the current you will pass through the circuit you set up to insure a good bond. The current to be used is _____.

9. Set up the apparatus as diagrammed below. LEAVE THE SWITCH OPEN. DO NOT CONNECT THE NEGATIVE TERMINAL ON THE LOW-VOLTAGE DC SOURCE.

APPARATUS FOR ELECTROPLATING



Have your instructor check your connections before proceeding.
INSTRUCTOR'S INITIALS_____.

10. CAREFULLY pour the acidic copper sulfate into the empty beaker. REMEMBER TO AVOID SPLASHES AND SPILLS. WASH IMMEDIATELY WITH RUNNING WATER AND CONTACT YOUR INSTRUCTOR SHOULD AN ACCIDENT OCCUR.

11. Connect the negative terminal on the low voltage DC source. The current required, from Step 8, is _____. Close the switch and QUICKLY adjust the setting of the rheostat until the AMMETER reads this current. OPEN THE SWITCH IMMEDIATELY.

12. Carefully remove the electrodes and dip them for a few seconds in the beaker containing water (Step 1). Then dip them in the beaker with the alcohol (Step 1). Allow them to dry by evaporation in the air for about 5 minutes. HANDLE THE ELECTRODES BY THE BENT ENDS AT ALL TIMES.

13. Weigh the electrodes individually. Be careful since these measurements must be as precise as possible.

    The mass of the cathode is _____.

    The mass of the anode is _____.

14. Replace the electrodes in the solution. BE CERTAIN THAT THEY ARE CONNECTED PROPERLY.

15. Close the switch and allow to operate for 30 or more minutes (or as directed by your instructor). Check the ammeter. Whenever necessary, make a fine adjustment of the rheostat to maintain the proper current reading (refer to Step 8 or 11). DO NOT DISTURB THE ELECTRODES.

16. When it is time to stop, open the switch.

17. Very carefully remove the CATHODE. DO NOT JAR OR SCRAPE IT ON THE BEAKER. GENTLY dip it in the beaker of water and then in the beaker of alcohol. Allow to dry in the air. DO NOT RUB.

18. Carefully weigh the cathode. Remember to be precise.

    The new mass of the cathode is _____.

19. Repeat the steps for removal, cleaning and weighing of the ANODE. Remember to be careful.

    The new mass of the anode is_____.

20. Compare the original and final masses of the cathode and anode.

    Are they different?

    Did the cathode gain the mass lost by the anode? Explain.

    Are there any losses you cannot account for? Explain.

21. Examine each electrode with the magnifying glass. How do they appear? Describe their appearance.

    How does their appearance compare with that which was observed originally (refer to Step 6)? Explain.

CLEAN UP YOUR WORK STATION. RETURN ALL EQUIPMENT TO THE PROPER LOCATION. DISPOSE OF SOLUTIONS AS DIRECTED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____.

Title: LAB--Electroplating

INSTRUCTOR'S NOTES

Preparation of copper sulfate solution --

160 grams copper (II) sulfate
1 liter water
10 milliliters concentrated sulfuric acid
20 milliliters alcohol

COMMENTS:

Title: LAB--Precision Casting

Unit: Metals

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To make a lead casting by the "lost wax" process.

Materials Required:

Block of paraffin wax; plaster of Paris; water; lead; mixing container; cardboard box (for molding); bunsen burner; striker; clay crucible; wire gauze; ring stand; ring; crucible tongs; knife; evaporating dish; asbestos mitts or gloves; apron; eye shield.

Information:

Small intricate shapes that are too expensive to forge or machine, or too difficult to cast by other methods, may be economically produced by precision casting. This method gives the products a smooth surface and accurate dimensions for small castings. Sometimes the fabricator chooses it where the quantity of objects to be made is too small to warrant the expensive dies required by other processes, but nevertheless is large enough to absorb the cost of molds and patterns required. Due to the many steps involved, precision casting is high in cost. It cannot compete with any of the other methods if it employs a metal that can be readily forged and machined. Because smoothness and accuracy become more difficult to maintain as the size of the object increases, articles weighing one pound or less are most practical.

In precision casting, a pattern is made through the pressing of wax or a plastic into a metal die. After a sprue pin of wax is welded on, the wax pattern is placed in a flask, which is then filled with a refactory mixture known as the investment mixture. For nonferrous alloys, this may be plaster of Paris mixed with silica; for alloys having higher melting points, it may be sand and a binder. The flask is then vibrated to remove air bubbles and to make sure that the surface of the pattern is in contact with the investment mixture. After the mixture has hardened, the flask is heated to remove any moisture. The temperature is now raised to as much as 2000°F, depending on the investment material and the material to be cast. At this temperature the wax will melt and burn out, leaving a cavity. Molten metal is then forced into the mold by gravity, by pressure, or centrifugally. The molds are slowly cooled and then broken open.

Title: LAB--Precision Casting

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR AREA CLEAN AND IN ORDER. PRACTICE SAFETY AT ALL TIMES.

PART ONE.....PREPARING THE MOLD

1. Prepare a block of paraffin wax about 2.6 cm (1 in) square and 1.3 cm (1/2 in) thick. This will be used for the pattern.

2. Prepare a rod-shaped piece of paraffin wax about 3.9 cm (1½ in) long and 0.7 cm (1/4 in) square. This will act as a sprue.

3. On the flat surface of one side of the paraffin block, carve out a design or make a hollow impression with some ornament.

4. Attach the paraffin sprue to the block.

5. Prepare a loose paste by mixing plaster of Paris and water.

6. The cardboard box will be used to help form the plaster mold. COMPLETELY ENCASE the paraffin wax with the plaster of Paris to a thickness of 2.6 cm (1 in.). Remember to cover the bottom. The sprue should extend above the surface of the plaster of Paris.

7. Shake the mold for a moment to permit any air bubbles to escape. Allow to dry for 1 or 2 days. INSTRUCTOR'S INITIALS_____.

PART TWO.....CASTING

1. When the mold is thoroughly dry, place it on the ring stand and CAREFULLY heat it with the bunsen burner to melt the wax. BE CERTAIN THAT THE CARDBOARD BOX HAS BEEN REMOVED FIRST.

2. When the wax has melted, hold the mold with tongs and pour the wax CAREFULLY into the evaporating dish. Continue to heat the mold until no more wax runs out.

3. In a clay crucible, melt enough lead to fill the mold cavity.

4. Using asbestos mitts or gloves and tongs CAREFULLY fill the hot cavity of the mold with the molten lead. BE CERTAIN TO KEEP YOUR HEAD AWAY.

5. Using tongs, grasp the mold and shake carefully to allow air bubbles to escape.

6. Allow mold to cool several hours.

7. CAREFULLY break open the mold and examine the casting. How closely does your casting resemble your original pattern?

CLEAN UP YOUR WORK STATION. RETURN ALL MATERIALS TO THEIR PROPER LOCATION. DISCARD ALL WASTES IN THE AREA DESIGNATED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____.

Title: LAB--Precision Casting

INSTRUCTOR'S NOTES

Cardboard box is used to retain plaster of Paris when forming the mold. It can be made from scrap cardboard and taped if necessary. Its size should be at least 1 inch larger than the paraffin block dimensions.

If it is desired to evaporate the wax from the mold, as is done in industry, the mold should be heated to a high temperature under a hood equipped with an exhaust.

COMMENTS:

PLASTICS

Title: LAB--Plastic Film

Unit: Plastics

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To make a plastic film.

Materials Required:

Test tube, test tube rack, sample of cellulose acetate butyrate plastic, acetone, 250 ml. beaker, warm water, piece of wire, apron, eye shield.

Information:

Much of the plastic you see today is in the form of a fine plastic film. Consider such items as sandwich bags, shower curtains, storm windows, painters drop clothes, pool covers, garment bags, and others. In most cases it is economical and resists water. Perhaps more importantly, it is relatively lightweight and strong.

Some films, such as Mylar, are very tough and do not tear easily. They can be used to make balloons for atmospheric studies. Poly-vinyl alcohol can be dissolved in water. Pre-packaged soap can be wrapped in it and it is simply dropped in the water--no mess, no fuss, no bother. Some plastics such as Saran (a vinyl polymer) can be sealed easily (self-sealing) and are very well suited for food packaging purposes.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR ARE CLEAN. PRACTICE SAFETY AT ALL TIMES.

ACETONE IS COMBUSTIBLE. DO NOT USE NEAR OPEN FLAME.

1. Get the sample of cellulose acetate butyrate plastic from your instructor.
2. Place sample in test tube (you may have to cut or bend it to fit in the tube).
3. CAREFULLY place about 4 ml of acetone into the test tube.
4. Place test tube and its contents in the test tube rack and allow plastic to dissolve in the acetone.
5. Fill a 250 ml. beaker, about 3/4 full, with warm water.

6. Make a loop in one end of the wire about 2 cm. in diameter. Bend the straight part of the wire near the loop so it is almost at right angles to the loop. This will be used to lift the film from the water.

7. When the plastic film has fully dissolved in the acetone, CAREFULLY pour it on the surface of the water in the beaker.

8. After 5 minutes lift off the plastic film with the wire.

   Describe the film you just made.

   How does it compare to some commercial films you are familiar with?

   How does it compare with the original sample you started with?

CLEAN UP YOUR WORK STATION. PLACE ALL MATERIALS IN THEIR PROPER LOCATION. DISPOSE OF ALL WASTES AS DIRECTED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____.

Title: LAB--Plastic Film

INSTRUCTOR'S NOTES

The wire is not absolutely necessary. However it does make it much easier to remove the film from the water.

COMMENTS:

Title: LAB--Thermosets and Thermoplastics

Unit: Plastics

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To distinguish a thermoset from a thermoplastic.

Materials Required:

Bunsen Burner, striker, tongs, evaporating dish, water, plastic samples, apron, eye shield.

Information:

Plastics are divided into two general types: THERMOSETS (or Thermosetting) and THERMOPLASTIC. Each has very definite and distinguishable characteristics. These characteristics are determined by the manner the molecules of these substances are arranged.

The molecules of thermosets are joined together in a long chain and are also cross-linked. Once hardened by heat and pressure, these plastics do not get soft again. They cannot be remolded.

The molecules in thermoplastics are arranged in a long (straight) chain. These plastics are softened by heat and do not change chemically upon repeated heating and cooling. They can be molded and then heated and remolded. Thermoplastics are generally softer and more flexible than the thermosets and can be formed into thin film and fine fiber.

Procedure:

FOLLOW ALL DIRECTIONS. KEEP YOUR WORK AREA CLEAN. DO YOUR OWN WORK. PRACTICE SAFETY AT ALL TIMES.

USE CAUTION WHEN CHECKING A PLASTIC FOR BURNING. SOME PLASTICS SPLATTER FLAMES. OTHERS HAVE FLAMES THAT ARE NEARLY INVISIBLE.

1. Get the plastic samples to be tested from your instructor.

2. Place some water in the evaporating dish. This is to be used to extinguish any burning plastic and to cool the tongs. NEVER TRY TO EXTINGUISH BURNING PLASTIC BY ATTEMPTING TO SHAKE IT OUT.

3. Set up the bunsen burner and adjust the flame.

Title: LAB--Thermosets and Thermoplastics

4. Take the thermosetting sample and WITH THE TONGS, HOLD IT OVER, BUT NOT IN, the burner flame.
   Does it soften?

5. Now hold the sample IN the flame.
   Does it burn?

6. Extinguish the flames, if any, and cool the tongs in the evaporating dish you prepared. INSTRUCTORS INITIALS_____.

7. Take the thermoplastic sample and, with the tongs, hold it OVER the burner flame.
   Does it soften?

8. Place the sample IN the flame.
   Does it burn?

9. Extinguish flames, if any, and cool tongs in evaporating dish.

10. What generalizations can you make concerning thermosets and thermoplastics?

    Make a list of plastics used in your home or shop and identify them as thermosets or thermoplastics.

CLEAN UP YOUR WORK AREA. PLACE ALL MATERIALS IN THEIR PROPER LOCATION. DISPOSE OF ALL WASTE MATERIALS AS DIRECTED BY YOUR INSTRUCTOR.

INSTRUCTOR'S INITIALS_____.

Title: LAB--Thermosets and Thermoplastics

INSTRUCTOR'S NOTES

Have students bring in properly identified samples of plastics from home or shop.

Samples should be from 1½ to 2 inches long.

Good thermoplastic specimens can be acquired from polystyrene sprues found in most plastic model kits.

Good thermoset specimens can be obtained from old pots and pans handles or electric wall plates. They should be cut up or broken to appropriate size for testing.

COMMENTS:

Title: LAB--Making a Plastic

Unit: Plastics

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To observe how a plastic can be made.

Materials Required:

100 ml. beaker, 3 250-ml. beakers, 50 ml. graduated cylinder, stirring rod, liquified phenol (90%), formaldehyde, concentrated hydrochloric acid, hot water, cold water, rubber gloves, apron, eye shield.

Information:

The word plastic means capable of being shaped or molder by pressure. The earliest plastic materials used by man were clay, pitch, and asphalt. Later, other materials such as waxes, rubber, and shellac were included. Today when we speak of plastics we mean the man-made materials put together in chemical laboratories. They are produced from combinations of carbon, oxygen, hydrogen, nitrogen, and other elements and are sometimes called synthetic resins.

In this lab, phenol (commonly called carbolic acid, C_6H_5OH), formaldehyde (HCHO), and hydrocholoric acid (HCl) will be used to produce a plastic. Phenol-formaldehyde plastics (also known as phenolics) are among the most versatile and inexpensive plastics. You may know it as Bakelite. It is used in the manufacture of telephones, electric switch parts, pot handles, toy transformers, and so on.

Procedure:

THIS IS A GROUP LAB. FOR REASONS OF SAFETY, IT WILL BE PERFORMED AS A DEMONSTRATION BY THE INSTRUCTOR. ALL STUDENTS ARE TO OBSERVE AND TAKE NOTES. SOME WILL BE ASKED TO ASSIST THE INSTRUCTOR.

1. In the 100 ml. beaker, CAREFULLY place 25 ml. of liquified phenol (90%) and 25 ml. of formaldehyde. Stir the mixture.

2. CAREFULLY add 25 ml. of concentrated hydrocholoric acid. Stir again for a few minutes.

3. Quickly invert a clean 250 ml. beaker over the one containing the liquids. This prevents splattering of the acids.

4. Touch the large beaker lightly with your finger. What has been given off during this reaction?

5. Allow the beaker to cool for 10 minutes.

6. Put on rubber gloves and remove the mass from the small beaker. Wash the mass thoroughly for several minutes.

7. Place the mass in a 250 ml. beaker containing hot water for a few minutes. Squeeze the mass.
   Describe what happens.

8. Shape the mass into the form of a ring and place it in a 250 ml. beaker of cold water for a few minutes.
   Is it still plastic?
   In this stage, is the material a thermoset or a thermoplastic? Explain.

9. Examine the final product.
   Describe the product.

Title: LAB--Making a Plastic

INSTRUCTOR'S NOTES

Due to the use of the acids in this lab, it is recommended that it be performed as a demonstration.

COMMENTS:

Title: LAB--Making Rayon

Unit: Plastics

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

To make rayon fibers.

Materials Required:

Bunsen burner, striker, ring stand, ring, wire gauze, paper towels, test tube, stopper, test tube rack, 250 ml. beaker, 100 ml. graduated cylinder, stirring rod, cotton, sodium hydroxide solutions (10% and 20%), dilute hydrochloric acid, carbon disulfide, apron, eye shield.

Information:

Not too long ago all fabrics were made from natural fibers such as wool, cotton and silk. When man learned the nature of these fibers, experimentation led to the discovery of ways to make similar fibers in the laboratory. Rayon was the first of these synthetic fibers to be made. Since then many other synthetic fibers have been introduced such as nylon, Orlon and Dacron.

There are four different processes used in making rayon. They are the nitrocellulose, cuprammonium, viscose, and the acetate processes. This lab will consider the viscose process as most rayon today is manufactured by this method.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR AREA CLEAN AND IN ORDER. PRACTICE SAFETY AT ALL TIMES.

REMEMBER TO HANDLE ALL SOLUTIONS CAREFULLY. AVOID SPLASHING AND SPILLING.

1. Set up the bunsen burner for a heating operation.
2. CAREFULLY place 100 ml. of a 20% sodium hydroxide solution in a clean 250 ml. beaker. USE CAUTION. DO NOT ALLOW THE SOLUTION TO COME IN CONTACT WITH HANDS OR CLOTHING--IT IS CAUSTIC.
3. Add a quantity of fluffed cotton to the solution.
4. GENTLY WARM the mixture for 3 to 4 minutes.
5. CAREFULLY remove the cotton with a stirring rod and squeeze out any excess solution between pieces of paper towels. REMEMBER TO USE CAUTION.

Title: LAB--Making Rayon

PAGE TWO

6. Place the cotton in a test tube and add enough carbon disulfide to cover it. Stopper the test tube and place it in the rack for 1 or 2 days. Clean the beaker.
INSTRUCTOR'S INITIALS_____.

7. Remove the material from the test tube. Press out the excess carbon disulfide and allow the remaining carbon disulfide to evaporate. Clean the test tube and stopper.

8. Put the material into the clean test tube. CAREFULLY place a 10% solution of sodium hydroxide in the test tube to just cover the material.

9. Stir the mixture thoroughly. Stopper the test tube and place it in rack. The test tube will be set aside until a sirupy mixture is formed (this reaction may take as long as a week). INSTRUCTOR'S INITIALS_____.

10. CAREFULLY fill the 250 ml. beaker about half way with dilute hydrochloric acid. REMEMBER TO USE CAUTION.

11. Hold the test tube containing the sirupy mixture about 45 cm. (18 in.) above the beaker. Pour the mixture as a fine thread into the hydrochloric acid solution (if the mixture is the correct consistency, it will pour in the form of sirupy threads).

12. CAREFULLY remove the threads from the hydrochloric acid solution with a stirring rod.

13. Wash the threads with water. Examine carefully.
What has happened?
How do the fibers compare with the original cotton?
Do some research. List the advantages and disadvantages of rayon. What precautions should be taken in laundering rayon garments?

CLEAN UP WORK STATION. PLACE ALL MATERIALS IN THEIR PROPER LOCATION.
INSTRUCTOR'S INITIALS_____.

ADHESIVES

LABORATORY INVESTIGATION OF ADHESIVES

INTRODUCTION

Adhesives for various purposes are formulated in this section of the Lab Manual.

First a general purpose adhesive is compounded, if, however the student wishes to compound for a specific purpose other adhesive compounds may be selected. For example, a wood, paper or tile adhesive is given. Also a cement and caulking compound adhesive are included. The above mentioned adhesives are all water based compounds. Therefore, to show an adhesive other than water based and used extensively in industry an Epoxy based adhesive is also included.

For those not acquainted with adhesive terminology a list of terms are included. Also product terminology that include definitions of plasticizers, solvents, thickeners, preservatives, defoaming agents, wetting agents, extender pigments, coalescent agents, stabilizers, and humectants are to be found.

The most important product of adhesives in modern industry is the latex that is used. This material, polyvinyl acetate, is an excellent example of colloidal chemistry and perhaps the instructor would like to demonstrate this product as an introduction lesson.

This demonstration can readily be done by the coagulation of the latex with acetic acid. This is described in the Lab Unit on General Adhesive - Part One.

In this Lab Unit the procedures will be given in both grams and parts so that any size quantities of adhesive may be compounded. Trade names (TM) where it is thought advisable will be given, the chemical names will be also included.

PRODUCT TECHNOLOGY

Plasticization

Practically all adhesive formulations contain some plasticizer or group of plasticizers. Polyvinylacetate latex alone, in most cases, is either too rigid or has extension properties below that needed for safe performance at the adhesive interface. Beside making the adhesive film more flexible, the additions of plasticizers have a decided effect on the wet tack of the emulsion. This tack and specific adhesive improvement is an important reason for the utilization of plasticizers in aqueous resin adhesives.

(Dibutyl Phthalate, Butyl Acetate, Diethyl Phthalate)

Solvents

With the increased usage of functionally coated surfaces (wax, etc.) and plastic films it is reasonably common to incorporate a variety of solvents in the polyvinylacetate latex adhesive to soften and increase adhesion to these surfaces.

(Acetone, Methanol, Methyl Ethyl Ketone, Perchlorethylene, Toluene)

Thickeners

In a good many cases, polyvinylacetate latexes are sold at viscosities considerably lower than the desired viscosity of the finished product.

A method to accomplish thickening is with a material which also imparts additional properties to the system -- polyvinyl alcohol comes into play here. A base adhesive thickened with polyvinyl alcohol would display better tack and tensile strength.

(Polyvinyl Alcohol, Sodium Polyacrylate, Carboxymethyl Cellulose, Starch, Methyl Cellulose).

Preservatives

Polyvinylacetate latexes in themselves are remarkably stable and free from bacterial decomposition. However, many of the thickeners and extenders added to the latex are extremely susceptible to bacterial attack and care should be taken in including preservatives in the formula. The quantities required usually range below 0.5% in the concentration.

(Benxoic Acid, Sodium Benzoate, Formaldehyde, Phenol Compounds, Mercury Compounds)

Defoaming Agents

The polyvinylacetate latex is a particle surrounded by a wetting agent (detergent) and therefore lends itself to foaming; therefore, the adhesive must be protected from foam.

(Octyl Alcohol, Silicones, Pine Oil, Tributyl Phosphate)

Wetting Agents

The addition of surface active agents (wetting agents or detergents) to promote penetration of adhesives is difficult.

Colloidal solution of latexes contain wetting agents during their polymerization and future addition is usually not necessary. The usual concentration of wetting agents in the adhesive is below 0.25%. The addition of a wetting agent is thought to be a secretive operation in the chemical industry and the nomenclature is usually not given, only the trade name. An example of a wetting agent or a surfactant is solium alkyd aryl sulfonate, also called a detergent.

(Tamol 731, Aerosol OT, Surfynol 104, Triton X-200 -- Trade Names)

Extender

The reason for extenders is primarily reduction in cost. For example, clay is a major extender and also helps to hold the adhesive from penetrating porous surfaces.

(Clay, Talc, Calcium Carbonate)

Inexpensive resin plastics are also implored and are called, in this case, tackifiers and perform the dual role of tackifing, plasticizing and extending the adhesive.

Humectants

The purpose of the humectant is to keep the surface of the adhesive wet. The use of a humectant also serves to plasticize the adhesive film. In most instances, the addition of 3% will produce an effect.

(Glycerine, Propylene Glycol, Hexylene Glycol, Ethylene Glycol, Urea, Glyoxal)

Coalescent Agent

This material is actually a solvent that dissolves to some extent the polyvinylacetate latex making it tackier.

(Carbitol - ester of cellusol)

Stabilizer

Calcium ions and trace metals in solution tend to precipitate latex solution, a phosphate acts to stabilize this situation.

(Sodium Tetra Pyrol Phosphate, Hexameta Phosphate, Calgon)

ADHESIVE TERMINOLOGY

Blocking	When dry adhesive film inadvertently bonds to the opposing substrate
Bond Strength	Pounds per square inch to break the adhesive assembly with failure occurring in or near the plane of the bond
Cold Flow or Creep	Movement of the glue line when the assembly is exposed to stress
Cure	To change the physical properties of an adhesive by chemical reaction which may be condensation, polymerization or vulcanization, usually accomplished by the action of heat and catalyst, alone or in combination with or without pressure.
Extender	A substance generally having some adhesive action, added to an adhesive to reduce the cost.
Filler	A relatively non-adhesive substance added to an adhesive to improve its working properties; i.e., permanence or strength.
Paste-Back	An increase in viscosity on aging. It usually is observed in starch mixtures, sometimes called retrogradation.
Polarity	In adhesive technology this refers to the relative surface charge of the material resulting from the molecular structure of the surface. Wood, paper, cloth and water are represented as polar surfaces; whereas rubber, benzene and some plastics are represented as non-polar surfaces.
Shortness	A qualitative term that describes an adhesive that does not string, cotton, or otherwise form filaments or threads during application.
Speed of Grab	The amount of time required for adhesive bonding.

Adhesive Terminology - 2

Syneresis	The exudation of small amounts of liquid on standing. A tendency to separate into one or more layers.
Tack	This is the resistance offered by an adhesive while in the liquid or semi-dry state to removal or separation of the surfaces.
Tackifier	A material, such as a rosin ester, added to synthetic resins to improve the initial and extended range of the adhesive film.

Title: LAB--Compounding a General Purpose Adhesive

Unit: Adhesives

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

1. To compound a general purpose adhesive.
2. To become acquainted with the chemicals used in this compound and why they are used.
3. To show a manufacturing cost reduction by compounding from basic chemicals.

Materials Required:

Depending upon the amount of adhesive the student wishes to compound, will determine the size of the container; however, it is suggested that one 1000 ml beaker, along with three 250 ml beakers be employed. A smaller 50 ml beaker should be on hand.

Gram scale; apron; eye shield; water; Polyvinylacetate latex (see chemical list of suppliers); Dibutyl Phthalate (plasticizer); Urea and Propylene Glycol (humectant); A mixer would be most helpful; however, stirring rods will suffice.

Information:

Before the compounding of the adhesive, the student or instructor should coagulate the polyvinylacetate latex with acetic acid (vinegar). This is shown in Part One. This demonstration is an excellent example of colloidal chemistry. The experiment shows how auto tires, rubber toys and even chewing gum and a variety of rubber objects are molded and produced.

The ease of manufacturing an industrial acceptable adhesive is readily shown in this lab experiment. It is worth noting that the raw material cost (RMC) of the finished adhesive is approximately .14/lb.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES. DO NOT THROW ANY MATERIAL IN SINK.

Title: LAB--Compounding a General Purpose Adhesive

PART ONE.....FLOCCULATING OF THE POLYVINYLACETATE LATEX

1. Place 20 grams of the polyvinyl latex in a 250 ml beaker.
2. Pour out 10 grams acetic acid (vinegar) in the 50 ml beaker. (Care should be taken if concentration of acetic acid is 80%).
3. Add the acetic acid to the polyvinylacetate latex and stir slowly.
4. Wash the filtrate thoroughly and examine the material produced.
5. Clean work area. INSTRUCTOR'S INITIALS_____.

PART TWO.....PREPARATION OF GENERAL PURPOSE ADHESIVE

1. In a 1000 ml beaker pour in 750 ml of polyvinylacetate latex solution. (Instructor may wish to reduce this by moving the decimal point one place to the left).
2. Add to the polyvinylacetate latex 150 grams of Urea (humectant). Allow sufficient time for the Urea to fully dissolve in the latex.
3. To the mix (Items 1 and 2) add 70 ml of Dibutyl Phthalate (plasticizer). Stir for five minutes.
4. Add to the combined mix (Items 1, 2 and 3) 30 ml of Propylene Glycol. This acts as a humectant and plasticizer.

   If a mixer is available, mix the ingredients until uniform adhesive is obtained. Also, if a viscometer is available, a viscosity of 500-550 cps should result.
5. Test the results of your adhesive on paper or wood. If a tensile tester is available this may be employed. The total solids of the adhesive should be 63%.
6. Clean work area. INSTRUCTOR'S INITIALS_____.

Title: LAB--Compounding a General Purpose Adhesive

PAGE THREE

Summary (in order of addition)

1.	Polyvinylacetate latex.....	75 parts
2.	Urea	15 parts
3.	Dituryl Phthalate	7 parts
4.	Propylene Glycol	3 parts
		100 parts

Instructor's Note:

Smaller amounts of adhesive can be formulated by each student and then combined with other students to save on chemical materials. The ease of formulation is readily shown in this experiment. An additional objective is to acquaint the student to the fact that costs are reduced when he learns to basically compound his materials that will be used in his industry.

Title: LAB--Compounding a Paper Adhesive

Unit: Adhesives

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

1. To compound a paper adhesive.
2. To become acquainted with the use of industrial chemicals.
3. To show a reduction cost of an adhesive when compounded in volume (cost per pound - .05)

Materials Required:

Depending on the amount of adhesive the instructor wishes to compound (see summary) it is suggested that one 1000 ml. beaker, along with three 250 ml. beakers be available.

Heating element; gram scale; metal scoop; apron; eye shield; water and a stirring rod is necessary. A mixer is most helpful. Polyvinyl Alcohol (thickener); Triton NE (wetting agent, see chemical list); Clay (Ga. Kaolin); Silicone (antifoam agent); Tamol N (dispersing agent).

Information:

This is a low cost paper adhesive using clay as an extender. It is therefore necessary to use a dispersing agent (Tamol N or Tetrasodium Pyrophosphate). The thickener is Polyvinyl Alcohol and is prepared in PART ONE. An antifoaming agent is used.

Approximately 100 grams will be used to formulate the following compound:

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. DO YOUR OWN WORK. KEEP YOUR WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

PART ONE.....PREPARATION OF POLYVINYL ALCOHOL THICKENER

1. Dissolve 5.3 grams of polyvinyl alcohol in 59.3 grams of water heated at a temperature of 180°F.
2. Stir until uniform.
3. Save thickener for the addition of other chemicals to compound paper adhesive.

Title: LAB--Compounding a Paper Adhesive

4. If a viscometer is available, the student may wish to test the viscosity of the thickener. (50 cps).

5. Clean work area. INSTRUCTOR'S INITIALS_____.

PART TWO.....PREPARATION OF PAPER ADHESIVE

1. To the polyvinyl alcohol thickener made in PART ONE, add 0.5 grams of dispersing agent (Tamol N or tetrasodium pyrophosphate).

2. Add 23 grams of clay (Kaolin) with good agitation until mix is smooth.

3. Add defoaming agent, two drops or 0.1 grams.

4. Finally, add 12 grams of polyvinylacetate latex and stir until the compound is uniform.

5. Clean work area. INSTRUCTOR'S INITIALS_____.

Summary (in order of addition)

PART ONE	1)	Polyvinyl Alcohol	5.3 parts
	2)	Water	59.3 parts
PART TWO	3)	Dispersing Agent (tetrasodium pyrophosphate or Tamol N)	0.5 parts
	4)	Defoamer	0.1 parts
	5)	Polyvinylacetate latex.....	12.0 parts

Title: LAB--Compounding a Paper Adhesive

INSTRUCTOR'S NOTES

Substitution of materials such as, wetting agent, dispersing agent, etc., may be made at the discretion of the instructor. A chemical list at the end of section will be helpful in this area.

COMMENTS:

Title: LAB--Wood Adhesive

Unit: Adhesives

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

1. To compound a thickening agent.
2. To compound a low solids wood adhesive.
3. To become acquainted with industrial use of chemicals.
4. Show cost reduction by compounding from basic chemicals.

Materials Required:

Depending upon the amount of adhesive to be formulated determines the size of the beakers. It is suggested that one 1000 ml beaker, along with three 250 ml beakers be available.

Gram scale; water; apron; eye shield; stirring rods or a mixer would be most helpful; Polyvinyl Alcohol (thickener) Borden Chem Lemol 42-88; Polyvinylacetate (see instructor's chemical list); Ethylene Glycol (anti-freeze).

Information:

This adhesive compound would be advantageous for carpentry students to experiment in their shop on wood products. It is a low cost wood adhesive costing approximately 0.13/lb. In this lab report, a total of 100 grams of the adhesive will be compounded; however, the instructor may increase this by referring to the Summary where "parts" are given.

Procedure:

FOLLOW ALL DIRECTIONS STEP-BY-STEP. DO YOUR OWN WORK. KEEP WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES.

PART ONE.....PREPARATION OF THE THICKENER (POLYVINYL ALCOHOL)

1. Place 14 grams of polyvinyl alcohol in a 250 ml beaker.
2. Stir in 86 grams of water.
3. Agitate until thickener is smooth.
4. This is a 14% solution of thickener. Save for addition to adhesive compound.
5. Clean work area. INSTRUCTOR'S INITIALS_____.

Title: Lab--Wood Adhesive

PART TWO.....COMPOUND APPROXIMATELY 100 GRAMS OF WOOD ADHESIVE

1. Pour into the 1000 ml beaker, 720 grams of polyvinylacetate latex.
2. Take only 23 grams of the polyvinyl alcohol thickener that was made in PART ONE and add it to the polyvinylacetate latex. Stir until uniform.
3. Add 1 gram of ethylene glycol (anti-freeze, acts as a mild coalescent agent) to the mixture of 1 and 2.
4. Stir until uniformity of adhesive is obtained. Add approximately 4 grams of water to obtain 44% solids.
5. Clean work area. INSTRUCTOR'S INITIALS_____.

Summary (in order of addition after the thickener is made):

1.	Polyvinylacetate latex	..... 72 parts
2.	Polyvinyl Alcohol	..... 23 parts
3.	Ethylene Glycol	..... 1 part
4.	Water	..... 4 parts
		100 parts

Title: LAB--Adhesive - Acoustical Tile

Unit: Adhesives

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

1. To be able to compound an acoustical tile adhesive.
2. To become acquainted with the chemicals used in this compound and why they are used.
3. To observe manufacturing cost reduction by compounding from basic chemicals.

Materials Required:

Depending on the amount of adhesive to be formulated will determine the size of the mixing container or beaker. It is suggested that one 1000 ml beaker, along with three 250 ml beakers be available.

Polyvinylacetate latex - homopolymer of large particle size; Methanol, methyl alcohol; water; apron, eye shield. A blender or mixer is most helpful in formulating, however, stirring rods will suffice.

Information:

This formulation is extremely simple to compound. The adhesive consists of three chemicals; namely, polyvinylacetate latexes, water and methanol.

The students should familiarize themselves with the properties of latex adhesive polymers. If they wish to formulate in earnest, they should know the type of latex polymer; i.e., polyvinylacetate is either homopolymer, copolymer or terpolymer. In addition, they should know the size of the polymer particles, the viscosity of the solution and the solids of the latex.

The latexes used in this adhesive are polyvinylacetate homopolymers of large particle size at 55% solid content. They have a high rigidity and stiffness for an acoustical tile adhesive.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES. DO NOT THROW ANY MATERIAL IN THE SINK.

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Title: LAB--Adhesive - Acoustical Tile

PAGE TWO

1. Add 70.5 grams of polyvinylacetate latex to 27.5 grams of water.
2. Add 2 grams of methanol slowly and with good agitation.
3. Check viscosity if possible. It should read 40-100 cps by a Brookfield viscometer.
4. Obtain a sample of an acoustical tile and test the adhesive according to the flow of adhesive on the tile. This adhesive has a solid content of 50%.
5. Clean work area. INSTRUCTOR'S INITIALS_____.

Summary (in order of addition)

1. Polyvinylacetate latex	.....	70.5 parts
2. Water	.....	27.5 parts
3. Methanol	.....	2.0 parts
		100.0 parts

Title: LAB--Adhesive - Caulking Compound

Unit: Adhesives

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

1. To be able to compound a caulking compound using chemicals that were primarily used in adhesive formulation.

2. To show that large volumes of caulking compounds can be manufactured at a substantial cost savings. Raw material cost of compound .14/lb.

Materials Required:

Depending on the volume of caulking compound to be compounded by the instructor or student, it is suggested that one 1000 ml beaker be available, along with four 250 ml beakers. An apron, eye shield, gram scale, metal scoop, stirring rod or a mixer is most helpful.

Polyvinylacetate latex (see sheet listing availability of chemical); Carbitol (cellosolve ester, dissolves organic compounds) which is a coalescing agent; Butyl Acetate and Dibutyl Phthalate (plasticizers); Glyoxal (humectant); Clay and Titanium Dioxide (pigments and extenders).

Information:

This is an excellent lab in that the student uses many industrial chemicals and ends up with a usable product. At the same time, students are acquainted with the function that each chemical has within the compound.

In this formulation, the student learns that the polyvinylacetate latex is the material that binds the pigments together, much like a paint. However, he sees the use of plasticizers that give flexibility to the caulking compound. Also a coalescing agent carbitol which makes the latexes tackier.

Two types of pigments are used in this formulation; clay as an inexpensive extender and titanium dioxide, an exceptional pigment that imparts whiteness to the caulking compound.

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES. DO NOT THROW ANY MATERIAL IN THE SINK.

Title: LAB--Adhesive - Caulking Compound

PAGE TWO

1. To the 1000 ml beaker add 52.5 grams of polyvinylacetate latex.
2. Add 3.5 grams of Carbitol (coalescent agent) to Number 1.
3. Add 4.0 grams of Butyl Acetate (plasticizer) to the mix 1 and 2.
4. Add 5.5 grams of Dibutyl Phthalate (second plasticizer) to mix 1, 2 and 3.
5. Add 1/4 gram of Glyoxal (humectant) to mix 1, 2, 3, and 4.
6. Add 1.5 grams of Titanium Dioxide pigment to the above.
7. Add 32.0 grams of Clay (if clay is not available use zinc oxide or $CaCO_3$ may be substituted). Add the pigments slowly to minimize lumping and continue stirring until uniform.
8. Clean work area. INSTRUCTOR'S INITIALS_____.

Summary (in order of addition)

1.	Polyvinylacetate latex	52.5 parts
2.	Carbital	3.5 parts
3.	Butyl Acetate	4.0 parts
4.	Dibutyl Phthalate	5.5 parts
5.	Glyoxel	0.25 parts
6.	Titanium Dioxide	1.5 parts
7.	Clay (see above)	32.0 parts
		100.0 parts Approx.

Title: LAB--Compounding a Reinforced Cement

Unit: Adhesives (Building Materials)

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

1. To compound a reinforced cement.
2. To become acquainted with chemicals used as adhesive and show an added use in building products (cement).
3. To observe how this compound can be used to bond new cement to old cement.

Materials Required:

Depending upon the amount of reinforced cement the students wish to compound will determine the size of the mixing container. It is suggested that one 1000 ml beaker, two 500 ml beakers, two 250 ml beakers and two 50 ml beakers be available.

Gram scale, apron, eye shield, water; Polyvinylacetate latex (binder); Dibutyl phthalate (plasticizer); Portland cement; Colored pigment, if desired (iron oxide); Sand (60 mesh silica).

Information:

This compound is used to bond new cement to old cement. It is an excellent lesson in using an adhesive product in a building product material. The cost of the additive (reinforced cement) is much higher than regular cement and therefore must be used only where the results would justify the cost.

Special polyvinyl latexes, made especially for the addition to cement latexes, must be well stabilized. (See chemical list).

Procedure:

FOLLOW DIRECTIONS STEP-BY-STEP. KEEP THE WORK AREA CLEAN. DO NOT DUMP ANY MATERIALS IN THE SINK. DO YOUR OWN WORK. PRACTICE SAFETY AT ALL TIMES.

(Based on 100 grams of compound).

1. Weigh out 10 grams of polyvinylacetate latex.
2. Add 1½ grams of dibutyl phthalate (plasticizer) to the latex.

Title: LAB--Compounding a Reinforced Cement

3. Add 3 grams of water to 1 and 2 with good agitation. Then add 22 grams of portland cement slowly with good agitation.

4. Add 56 grams of sand in the same manner as the cement.

5. Finally, add enough water to produce a trowelable mix. (No more than 6 grams).

6. Clean work area. INSTRUCTOR'S INITIALS_____.

Summary (in order of addition)

	1. Polyvinylacetate latex	.....	10.0 parts
	2. Dibutyl phthalate	.....	1.5 parts
	3. Water	.....	3.0 parts
	4. Portland cement	.....	22.0 parts
If desired	5. Colored pigment (iron oxide)	.....	4.0 parts
	6. Sand (60 mesh silica)	.....	56.0 parts
	7. Water (to produce a trowelable mix)	.....	6.0 parts (max.)
			100.0 parts Approx.

Title: LAB--Compounding an Epoxy Adhesive (with filler)

Unit: Adhesives

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

1. To compound an epoxy based adhesive.
2. To observe how metal fillers may be incorporated into epoxy adhesives.

Materials Required:

Mixing container, preferably disposable, size according to the quantity of epoxy adhesive to be compounded. Container to be used to clean metal to be bonded.

Spatula or wooden tongue, along with an apron, eye shields, depressors may be employed, Epoxy resin (molecular weight 400), Diethylene triamine, aluminum powder (Al_2O_3), Silica, Concentrated HCl, Hydrogen peroxide, Formaldehyde, water.

Information:

Epoxy-based adhesives (no water, 100% solids) will give excellent bonds to steel, aluminum, brass, copper and most metals; also to most thermosetting plastics (epoxies, phenolics, alkyds) and to glass, wood, concrete, paper or cloth.

The surface of the material to be bonded must be clean. In this application, metal to metal may be tested with the following epoxy adhesive if time permits.

The metal should be cleaned with the formulation shown in Part One (below).

The metal filler may be taken from the machine shop by grinding either aluminum metal or stainless steel.

Procedure:

FOLLOW THE PROCEDURE STEP-BY-STEP. ALWAYS KEEP THE WORK AREA CLEAN. PRACTICE SAFETY AT ALL TIMES. DO NOT THROW MATERIALS IN SINK.

PART ONE..... TO CLEAN STAINLESS STEEL IF PART OF THE LAB.
TO BOND METAL TO METAL.

1. Concentrated hydrochloric acid HCl ..... 50 parts
2. Formalin solution ..... 10 parts
3. 30% hydrogen peroxide H_2O_2 ..... 2 parts

Title: LAB--Compounding an Epoxy Adhesive (with filler)

4. Water ..... 45 parts

5. Dip the metal in this solution for ten minutes. Parts are by weight.

PART TWO.....EPOXY ADHESIVE

1. Epoxy resin (molecular weight 400) ..... 100 parts
2. Diethylene triamine ..... 11 parts
3. Aluminum powder (Al_2O_3) ..... 30 parts
4. Uncompressed Silica as needed for viscosity.
5. Clean work area. INSTRUCTOR'S INITIALS_____.

Title: LAB--Compounding an Epoxy Adhesive (with filler)

INSTRUCTOR'S NOTES

It should be noted that on occasion some person may show a reaction to the amine chemical used as a curing agent in epoxies. If any sign of skin reaction occurrence shows up, the student should not handle the curing agents.

COMMENT:

PAINTS

LABORATORY INVESTIGATION OF PAINTS

INTRODUCTION

This section of the laboratory manual attempts to simplify the formulation of latex based paints or so-called water based paints.

These formulations offer an excellent use of many chemicals and at the same time, end up with a usable product; namely, either an interior or exterior paint or a masonry paint.

Listed below are the basic chemicals that are added to a latex paint and the reasons for their addition:

Chemicals Added		Use
1. Water	.....	Vehicle
2. Phosphates	.....	Dispersing Agent
3. Wetting Agent (detergent)	.....	Forms Colloidal Solution
4. Na_2CO_3	.....	pH Buffer
5. Phenylmercuric Acetate	.....	Preservative
6. Alcohols	.....	Defoamer
7. Methyl Cellulose	.....	Thickener
8. Ethylene Glycol	.....	Anti-Freeze
9. TiO_2, ZnO, $CaCO_3$, Fe_2O_3	.....	Pigments
10. a. Acrylics b. Polyvinylacetate c. Styrene-Butadiene	.....	Latex Binder

On the following page, other explanations and definitions of paint terminology will be given.

PAINT TERMINOLOGY AND DEFINITIONS

Binder	The non-volatile portion of the coating which is the film forming ingredient used to bind the pigment particles together.
Coagulation	The precipitation of colloidal into a solid mass.
Coalescence	The fusing together of latex or resin particles to form a film during the evaporation of water in the drying process.
Extender Pigment	Extender pigments have low refractive indexes with poor hiding. They most often are used to impart properties other than hiding.
Let Down	The portion of the paint formula added after the paint is ground.
PVC (Pigment Volume Concentration)	This is expressed as a percent and is the ratio of the volume of the pigment to the volume of the pigment, plus volume of the non-volatile vehicle.
Prime Pigments	Usually titanium dioxide or zinc oxide added to the paint to give maximum hiding. Refractive Index of 2 or better.
Latex	Used as a binder. Acrylics, Polyvinyl Acetate or Styrene Butadiene.
Dispersing Agent	Function to insure as complete as possible separation of the pigment particles (Potassium Tripolyphosphate).
Wetting Agent	Function to lower the surface tension and are usually non-ionics (Surfynol, Emulphor, Tergitol, Igepal).
Preservatives	To prevent bacterial growth in a latex water based paint (Phenylmercuric Acetate).
Freeze Thaw	Material added to prevent a water based paint from freezing (ethylene glycol).
Thickener	A material that imparts an increase in viscosity to the paint (Methyl cellulose will be used in the following paint formulations).

Defoamer	Material to lower the surface tension and thus reduce foaming of a water based paint that contains wetting agents. (alcohols).
Pigments	Primarily inorganic pigments will be used; however, organic pigments that are water soluble may be used. ($CaCO_3$), ZO, Clays, Fe_2O_3, TiO_2, Silica, $BaSO_4$.)
pH Buffer	The paint formulation based on latexes should have a pH of between 7.5 - 8.5 (Na_2CO_3).

Title: LAB--Interior White Paint (Latex)

Unit: Paints

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB. ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

1. To compound an interior latex paint.
2. To acquaint the student with the chemicals used in paints and why each chemical is employed.

Materials Required:

Apron, eye shield, access to water and a gram scale, along with containers for mixing purposes. (Containers depend on the amount of paint to be compounded).

Chemicals needed: water, Na_2CO_3, detergent (emulphor), ethylene glycol, bacteriacide, thickener (methyl cellulose), pigments ($CaCO_3$, clays, Fe_2O_3 and TiO_2), phosphates (tripolyphosphates or sodium pyrophosphate), latex (polyvinyl-acetate).

Mechanical mixer or blender is also needed.

Information:

It is not the function of this lab to compound a latex paint to perfection and some leeway should be considered in the compounding of the paint by the instructor and student. It is not the function of this lab to become an expert in paint technology but to acquaint the student with chemicals employed in this industry.

Mixing of the ingredients is most important and must be done to receive a smooth paint. The viscosity of the paint is also important and is given in the paint industry in Krebs Units (K.U.), which is the standard unit for measuring paint viscosity. Here the instructor may add thickener (methyl cellulose) according to worability of the paint.

This lab is rather time-consuming and might be best done in parts. Note that while preparing the paint compound, the first four materials added form, or make, a collodial solution which, in turn, is an excellent detergent in itself.

The formulation will be given in grams to compound approximately a half-pint of paint. 257

Title: LAB--Interior White Paint (Latex)

Procedure:

FOLLOW ALL DIRECTIONS. DO YOUR OWN WORK. KEEP YOUR WORK AREA CLEAN. DO NOT THROW ANY MATERIALS IN THE SINK. PRACTICE SAFETY AT ALL TIMES.

STEP 1. to 15 ml. of water add:

0.5 grams sodium alkylaryl sulfonate (detergent)
0.1 grams sodium pyrophosphate (dispersing agent)
0.1 grams Na_2CO_3 (pH buffer)

Stir the above solution and note that you have formulated a detergent.

STEP 2. Weigh out the following pigments:

12 grams TiO_2 (titanium dioxide)
12 grams ZnO (zinc oxide)
12 grams $CaCO_3$ (calcium carbonate)

Add to the above mixture. A blender is most helpful for this purpose. If excess foaming develops, add a few drops of alcohol as a defoamer.

STEP 3. In a separate beaker add 3 grams of methyl cellulose (thickener) to 100 ml. of water and stir well. Add the mixture to the above pigment-detergent mix (Steps 1 and 2) and continue to mix in blender.

STEP 4. Measure out 40 ml. of latex (binder) and add to the above mix. If paint is not thick, more methyl cellulose may be added.

NOTE: In consideration for the length of time in formulating this paint, the anti-freeze (ethylene glycol) nor the preservative (phenyl mercuric acetate) were added because of the small amount of these materials needed; however, the student should note their necessary function.

Clean work area. INSTRUCTOR'S INITIALS_____.

Title: LAB--Exterior White Latex Paint (For Wood or Masonry)

Unit: Paints

Course: Chemistry/Materials

NOTE: SAFETY EQUIPMENT MUST BE WORN DURING THIS LAB.
ALL ACCIDENTS MUST BE REPORTED TO YOUR INSTRUCTOR.

Purpose:

1. To compound an exterior white latex paint.
2. To acquaint the student with industrial chemicals used in paint formulation.
3. To acquaint the student with trade names used in paint manufacturing and to show physical qualities of a finished paint.

Materials Required:

Apron, eye shield, access to water and a gram scale, along with containers for mixing purposes.

Chemicals needed: Thickening agent (methyl cellulose); Detergent (Tamol 73125%); Preservative (phenylmercuric acetate); Defoamer (alcohol); Coalescence agent (dibutyl phthalate); Anti-freeze (ethylene glycol); Pigments (TiO_2, Mica, Clay); Latex (polyvinylacetate type).

Information:

This compound of an exterior white latex paint will be given in pounds to show how the paint is formulated in industry. The student can convert the pounds to grams and compound the desired amount of paint.

The following physical characteristics will show how the final gallon of paint should correspond to what is sold at a paint store.

Weight per gallon	11.12 lbs.
PVC (see definitions)	34.5%
Solids by weight	51.8%
Raw Material cost (RMC)	$1.36/gal.
Viscosity (Kreb Units KU)	72 - 85
pH	7.5 - 8.5

Title: LAB--Exterior White Latex Paint (for Wood or Masonry)

Procedure:

This formulation is given in pounds of approximately 1,235 lbs. Converted to gallons, this would manufacture 111 gallons. Students should convert the pounds to grams and compound a desired amount of paint.

Add the ingredients in order given:

1.	Water	.....	150.0 lbs.
2.	Potassium Carbonate (buffer)	.....	1.0 "
3.	Detergent: (Tamol 731 25%)	.....	3.0 "
4.	(Emulphor EL-719)	.....	3.0 "
5.	Coalescence Agent (Dibutyl Phthalate)	.....	8.0 "
6.	Anti-Freeze (Ethylene Glycol)	.....	18.0 "
7.	Defoamer (Alcohol)	.....	1.0 "
8.	Thickener (Methyl Cellulose 3% 4000 cps.)	.....	100.0 "
9.	Pigments: Mica	.....	25.0 "
10.	TiO_2	.....	175.0 "
11.	Clay	.....	175.0 "

Mix the above ingredients preferably with a high speed disperser for at least ten minutes and add the following let down.

Latex (Polyvinylacetate)	450.0 lbs.

Adjust with thickener if desired

Clean your work station. Be certain that everything is in order as directed by your instructor.

Instructor's Initials_____

CHEMICAL LIST

Latexes:

- Polyvinyl Acetate
- Acrylic
- Styrene Butadiene

Plasticizers:

- Dibutyl Phthalate
- Diethyl Phthalate
- Butyl Acetate

Humectants:

- Urea
- Glycerine
- Ethylene Glycol
- Propylene Glycol
- Hexylene Glycol
- Glyoxal

Thickeners:

- Polyvinyl Alcohol
- Starch
- Carboxymethyl Cellulose (CMC)
- Methyl Cellulose

Wetting Agents:

Trade Names (TN)

- Tamol 731
- Surfynol 104
- Aerosol OT
- Triton X-100

Extender Pigments:

- Clays
- Mica
- Calcium Carbonate
- Talc

Prime Pigments:

- Titanium Dioxide
- Iron Oxide
- Zinc Oxide
- Dyes

Defoaming Agents (antifoam):

- Silicones
- Alcohols
- Pine Oil
- Tributyl Phosphate

Anti-Freeze Agents:

- Ethylene Glycol

Coalescent Agents:

- Carbitol (TN)

Solvents:

- Mehtanol

Preservatives:

- Phenylmercuric Acetate

Dispersing Agents or Stabilizers:

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- Tripolyphosphate
- Sodium Pyrophosphate
- Hexametaphosphate

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Epoxy Resins:

Curing Agents:

Diethylene Triamine

Industrial Chemicals:

Hydrochloric Acid
Peroxide
Formaldehyde
Sulphuric Acid

Miscellaneous:

Portland Cement
Silica